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THE DECENNIAL PUBLICATIONS

OF

RADIAL VELOCITIES OF TWENTY STARS

WALTER S. ADAMS

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THE DECENNIAL PUBLICATIONS

RADIAL VELOCITIES OF TWENTY STARS HAVING SPECTRA OF THE ORION TYPE

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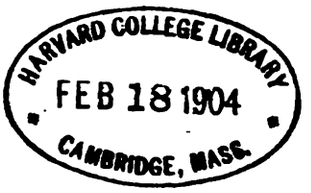

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RADIAL VELOCITIES OF TWENTY STARS HAVING SPECTRA OF THE ORION TYPE

EDWIN B. FROST AND WALTER S. ADAMS

INTRODUCTION

THE determination of the velocity of a star in the line of sight according to Doppler's principle was first attempted by Huggins in 1868. His observations were followed by those of Vogel three years later, and the validity of the method may be considered to have been established by these investigations, together with others dealing with the motions of planets and the rotation of the Sun. Visual observations of the displacements of the lines in stellar spectra from the positions of corresponding lines in the spectrum of a vacuum tube are, however, of extreme difficulty, and measurements which can be regarded as at all accordant are only possible with the most powerful telescopes and the brightest stars. It was not until the photographic method was applied to this class of observations by Vogel in 1887 that results of an accurate character were obtained. The determinations of the radial velocities of fifty-one stars by Vogel and Scheiner, described in detail in the seventh volume of the *Publicationen des Astrophysikalischen Observatoriums zu Potsdam*, constitute the foundation of the modern methods of observing stellar motions in the line of sight.

The next great advance was made by Campbell in his design of and work with the Mills spectrograph of the Lick Observatory, described in the *Astrophysical Journal*, Vol. VIII (1898), pp. 123–56. The use of iron as a comparison spectrum (previously tried by Vogel and by Deslandres, but not regularly employed by them), together with the closest attention to the optical and mechanical construction of the instrument and great refinement in the measurement of the plates, enabled Campbell to increase greatly the accuracy of the determinations, so that the natural unit became the kilometer per second, instead of the sevenfold greater German geographical mile employed by Vogel.

The necessity for the greatest attainable rigidity of the spectrograph, to prevent flexure, and for the maintenance of the prisms at a constant temperature, became apparent from the experience of all observers engaging in spectrographic work, and has led to further improvements in the current type of spectrograph, and tended to increase still further the precision of measurements of radial velocities. The observations given in the present paper constitute a part of the first year's work with the Bruce spectrograph of the Yerkes Observatory, which was completed in the autumn of 1901, and has since then been systematically used in determining stellar motions in the line of sight.

The spectra of the *Orion* type are of an especial interest to the astrophysicist, as they seem unquestionably to occupy a position very early in the scale of stellar evolution. Their chemical constitution is simple, the chief elements showing lines being hydrogen, helium, oxygen, silicon, nitrogen, and magnesium. The presence of helium is the principal characteristic of the type, whence they are frequently called helium stars. The broad and diffuse nature of most of the lines in these spectra renders them less adapted to precise measurement for radial velocity; moreover, the dispersion of the Bruce spectrograph is rather high for such lines, so that it is quite out of the question to expect any such accuracy in the determined velocities as may be obtained for stars of the solar type. A judgment as to the accuracy reached with this instrument, and with the methods employed in measuring and reducing the plates, should be based upon the results given in the section on the control plates of the Moon, planets, and certain standard stars of the solar class (pp. 18–32). The optical features of the Bruce spectrograph were especially planned, however, to cover a region of spectrum not naturally included by most of the large spectrographs engaged in line of sight work, and this region (centering near the strong helium line at λ 4471 and the characteristic magnesium line at λ 4481) was chosen as

particularly well suited for work on stars of the *Orion* type. These stars, furthermore, have hitherto been little observed for radial velocity, so that the field is a comparatively open one. The twenty stars included in this paper were not chosen by any definite principle of selection, but merely represent those stars of which three or more spectrograms have been obtained during the past year, from an observing list of something over one hundred stars shown to be of the *Orion* type by the investigations of Vogel and Wilsing.[1] But stars of this type previously known to be spectroscopic binaries, and those which have been found to be such during the progress of this work, have been excluded from the list. These last named are six in number, and will be discussed in due time elsewhere.

INSTRUMENTS

The Bruce spectrograph was designed and largely constructed at the Observatory, with funds provided by the late Miss Catherine W. Bruce, of New York city, amounting to twenty-three hundred dollars, supplemented by a grant of five hundred dollars from the Rumford fund of the American Academy of Arts and Sciences. As a detailed description of the spectrograph has already been published,[2] it will be necessary to recall here only some of the essential features of the instrument and its use in connection with the great Yerkes refractor. A correcting lens of 57 mm. aperture is placed in the cone of rays from the forty-inch objective, at a distance of about 100 cm. from the slit, and unites the rays so that the spectrum of a star is of uniform width for about 100 tenth-meters on either side of λ 4500.

The triple collimating lens, of 51 mm. aperture and 958 mm. focus, was replaced during the year by a quadruple "isokumatic" lens, designed by Professor Hastings, which was originally ordered but could not then be supplied. The new collimator is of the same aperture and focus, and slightly increases the field of good definition, which was already quite satisfactory.

The three prisms are of specially annealed Jena glass, figured by Brashear, and have angles of 64°34′, with an index for $\lambda = 4500$ of $n = 1.6724$. Their size is such as to transmit the full beam from the collimator of 51 mm. diameter, with allowance for the increased size of the beam after dispersion in the first and second prisms.

Two cameras are provided with the instrument; A, a Zeiss anastigmat of 71 mm. aperture and 449 mm. focus; and B, a Hastings triple of 76 mm. aperture and 607 mm. focus. The two series of plates taken with the spectrograph are designated as A and B according to the camera lens employed. The range of fair focus is somewhat greater in (tenth-meters) for the shorter camera, but the superior scale of camera B gives it the advantage in the range covered. The photographic "speed" of the two cameras is practically identical: the same exposure-time is required for the same object under equal atmospheric conditions. We account for this unexpected circumstance by the losses of light on passing throngh the five component lenses of the anastigmat.

Camera B has given us serious trouble by becoming astigmatic at intervals, without any known cause external to the lens. We have attributed this to strain produced by the cement (balsam), and the notes under the "journal of observations" show that the lens has been several times recemented by the maker. When a trial plate shows any defective performance of camera B (commonly fringes on the sides of the comparison lines), camera A is always used. It should be mentioned here that we find it much more accurate and satisfactory to test a lens by photographing the emission lines from metallic electrodes rather than the absorption lines of the solar spectrum. Of the plates referred to in this paper fifty-four have been taken with A and eighty-two with B.

The principal changes which have been made in the instrument since the descriptive article was written (in December, 1901) for the *Astrophysical Journal* (*loc. cit.*) are the following:

[1] "Untersuchungen über die Spectra von 528 Sternen," *Publicationen des Astrophysikalischen Observatoriums zu Potsdam*, Bd. XII, Theil I.

[2] EDWIN B. FROST, "The Bruce Spectrograph of the Yerkes Observatory," *Astrophysical Journal*, Vol. XV (1902), pp. 1-27.

The bar containing the windows, which determine the length of slit used at a given exposure (a single window for the star-light, a double window for spark-light), has been placed slightly in front of the slit instead of behind it, as formerly. This made the tips of the spark lines much sharper than they had been previously.

To insure the full and uniform illumination of the collimator lens by the light from the source of comparison spectrum, two changes and two additions have been made. The use of the concave mirror to project the image of the spark or tube upon the slit has been abandoned, as the electrodes themselves cut out an appreciable amount of the cone from the mirror, and admitted the possibility of non-uniform illumination of the collimator. The simple biconvex lens originally provided as an alternative has been regularly used for all of the later plates described in the journal of observations.

The plane silvered mirror at first used to reflect the comparison light 90° downward into the slit has been replaced by a diagonal prism.

A small ground glass diffusing screen has been mounted 20 mm. in front of the slit, and is turned into position when the comparison spectrum is being photographed. This should insure a uniform source filling a much larger angle than that subtended at the distance of the slit by the collimating lens, and it has proved entirely satisfactory. The idea was taken from the Potsdam spectrograph, where a ground glass screen diffuses the light from the arc lamp which there serves as the source of the comparison spectrum.

For testing the illumination of the collimator Campbell's practice has been followed of placing a photographic plate in a small holder directly over the aperture of the lens. The exposure is then made to the light of the spark. The negative gives a much more satisfactory test of the illumination than is possible by the usual visual method.

The method of guiding during the exposure on the star, by the light reflected from the symmetrically inclined slit-jaws, has proved very satisfactory. When desired, the observer can, by simply turning a pinion, throw into the guiding telescope the light of the star or spark reflected at the first surface of the first prism. The method thus combines the advantages of the methods of Huggins and of Vogel.

The temperature case which envelopes the whole spectrograph has also given entire satisfaction in its operation. Although the electric heating is not automatic, it has not been found too much of an inconvenience for the observer to read the thermometers from time to time during an exposure, and to turn on the current as necessary. A change of 1° C. in the temperature within the outer case usually causes a change of about 0°.1 within the inner case (prism-box).

THE PLATES OF SPECTRA

The dispersion and scale of the plates for cameras A and B are as follows:

Wave-Length	Angular Dispersion for One-Tenth Meter	Tenth-Meters per mm.	
		Camera A	Camera B
4300	45.7	10.0	7.4
4500	33.8	13.5	10.1
4700	26.0	17.6	13.1

A test of the practical separation of close lines in the solar spectrum, photographed on fine-grained plates, gave almost identical results with those described for the Mills spectrograph and the largest Potsdam spectrograph. On the fastest plates, which are used for stellar spectra, the least separable distance is of course less, and is about 0.2 tenth-meters at the center of the plate (λ 4480).

The range of spectrum in sufficiently sharp focus for determining displacements for velocities is

on properly exposed plates—for Camera A, from about λ4300 to λ4700; for Camera B, from about λ4340 to λ4700. For merely qualitative work, the range usable would be considerably greater.

The plates used were Seed's "Gilt Edge" 27, and Cramer's "Crown." At the close of the period covered here Seed's double-coated, non-halation plates were tried, with very satisfactory results. The size of the negatives is $1\frac{5}{8}$ in. × 4 in. (42×102 mm.). The developer employed was rodinal or hydrochinon, commonly the former.

Comparison spectrum.—The rotating drum of the spark apparatus provides for the use of three metallic electrodes and a vacuum tube. On the plates discussed in this paper we have always employed titanium, and sometimes, in addition, iron or chromium electrodes, or the helium tube (which contains hydrogen as an impurity and gives also the hydrogen lines). We have used titanium in preference to iron for the standard comparison spectrum for the past three years, and obtain with it sharper and more numerous lines in the region of spectrum covered than with iron. In order to suppress the air lines when iron is used, a small self-induction coil was constructed in 1899 by Leeds & Co., of Philadelphia, according to specifications of Frost. It has an outer diameter of about 40 mm. and a length of about 42 cm. and is separated into sections with binding posts, so that 50, 100, 200, or 500 turns, or any combination of them, may be used. There is no core. The coils are insulated in the same manner as for the secondary of an induction coil. The air lines with the iron spark are greatly cut down when fifty turns are used, and can be entirely suppressed with a greater number of turns. The lines of the other metallic spectra are also rendered sharper by the use of the self-induction.

The current for the primary of the induction coil furnishing the current for the spark is taken from the 110-volt mains, and is reduced by properly arranged resistance coils so that from four to fourteen volts can be tapped off. The induction coil is stationary, and the secondary current is carried in an excellent cable, reaching the spectrograph in any position of the telescope with comparatively little loss of potential.

MEASURING MACHINES

All our measurements of spectra were formerly made with the familiar Zeiss comparators, having two microscopes, one for the negative and the other for the graduated scale. While these instruments are excellent, and have the advantage of depending upon an invariable scale instead of a screw, they are nevertheless rather slow in action, and the eye is strained in alternating between the microscopes with their different degrees of illumination of field. In 1901 two screw machines were therefore ordered from William Gaertner & Co., of Chicago, according to specifications by Professors Hale and Frost, and they have been almost exclusively used in the measurements covered by this paper. An idea of the instrument may be gained from the accompanying plate. The box casting is 23 cm. long, 8.5 cm. wide, and 5 cm. deep. To this the microscope is attached at an angle convenient for observing. The stage or plate-carriage moves in accurately figured ways on a second carriage which moves with the nut of the micrometer screw. The stage may be unclamped from the lower carriage and may be rapidly moved in a direction accurately parallel to the axis of the screw, through a distance of 40 mm. This allows the plate to be quickly aligned under the microscope, and to be rapidly examined before it is measured. A fine screw at the observer's left permits a slight adjustment of the position of the stage after it is clamped to the lower carriage. Thus the stage may be set so that any desired reading of the micrometer screw will correspond to a given position on the plate. The screw is of 10 mm. diameter and 10 cm. length, with a pitch of one-half millimeter. Great care was given by Mr. Gaertner to its construction. The nut is 28 mm. long. A weight attached to it by a light wire over a pulley not shown in the figure removes the small amount of lost motion otherwise present. The screw head is 80 mm. in diameter and is graduated with 500 divisions, so that 1 division = 0.001 mm. or 1 micron (μ). Every tenth division is doubly numbered, *e. g.*, as 39 and 89, so that the readings can be taken off the head directly for a whole millimeter instead of a half (one revolution).

Whole millimeters are read from a scale along the ways of the carriage. The microscopes are from Zeiss, and have the valuable feature of a variable magnification (ranging from about six to thirty diameters) as the objective is moved along a graduated scale. The reticle was ruled on glass at the observatory, and consists of a single fine line and a close pair. There is also provided an eye-piece micrometer which is not used. The whole eye end, including the reticle, can be slightly rotated so that the lines can be made perpendicular to the motion of the screw.

METHOD OF MEASUREMENT

After the negative has been aligned so that the edge of the spectrum moves along some mark or dust particle in the field, the upper carriage or stage is moved so that any desired value is given to the initial setting, and is then clamped, after which it is moved only by the screw. We commonly first place the plate on the stage so that the violet end of the spectrum will appear toward the left in the microscope, when the micrometer settings will increase with the wave-lengths. Four settings are then made on each star line, alternating each time in the direction from which the line is brought under the "thread" of the reticle. Four settings are also made on each comparison line, two each on the portions of the comparison line above and below the star spectrum, with the same alternation in the direction of approaching the thread. Care is taken that there shall be no change in the illumination of the plate during the measurement, and the mirror is rarely touched between plates. A change in the angle of the mirror during measurement would be likely to produce a noticeable shift in the apparent position of the lines.

The point in the comparison line (dark on the negative) at which the line is bisected by the thread may be different according to the practice of different observers. Thus it is the habit of Frost to make the setting at a point one-third of the length of the comparison line away from its inner end; while Adams makes his settings on the inner tips of the comparison lines. On star lines, of course, the setting is always made at the center. The correction for curvature will therefore be regularly different for the two observers. In case of very strong comparison lines, the accuracy of the settings may be somewhat increased by the use of the double thread of the reticle, but this has been very seldom done in these measures. The single thread is invariably the more suitable for the star lines (white on the negative).

After the plate has been measured in one position it is reversed on the stage so that the violet end will appear toward the right in the microscope, and the micrometer readings will decrease with increasing wave-lengths. The new position is so adjusted that the readings will add up some convenient number of whole millimeters when combined with the corresponding readings for the previous position of the plate. If this whole number is 80, then the averages of the four settings in the second position of the negative will be successively subtracted from 80.0000, and the remainder will be very closely equal to the previous average, with which it is now combined to form the Mean of the Settings. If the measurements in the two directions are not made consecutively, the observer is careful to see that the second measure is made when the comparator is at the same temperature as at the first measure.

It should be understood that the measurement of a plate in each position is a single, homogeneous process, yielding results which may be considered absolute, within the limits of error involved. That is, the settings are not first made on a star line and then on a comparison line as a pair, giving a differential value of the distance between the two; but the settings are progressively made along the plate until the whole measurement is complete for that position on the stage. The question of the choice of lines to be measured is taken up in the next section.

1. *Length of lines (width of spectrum).*—Two sets of windows have been used during the year, each set yielding a different length of lines (both star and spark) for the two cameras. With the narrower windows the length of the lines of both star and comparison spectrum is 0.17 mm. for camera B, and 0.13 mm. for camera A; with the larger windows, which have been used almost exclusively since

October 31, 1901, the length is 0.40 mm. for camera B, and 0.29 mm. for camera A. With average conditions of atmospheric steadiness, it is necessary during the exposure to move the star image back and forth through a small amplitude on the slit by the electric slow-motions, in order that the width of the star spectrum may correspond to the full width of the window. On faint stars the star spectrum is usually kept somewhat narrower than the full width, thus diminishing the necessary exposure time.

2. *Curvature of the lines.*—Correction is made for the curvature of the comparison lines by means of tables computed by Ditscheiner's formula, which has been shown by Adams to be accurate for long slits.[3] The amount of the correction (x) is indicated for the two cameras by the following extracts from the tables. The distance from the center of the star lines to the point for which the correction applies is denoted by z:

z	Camera A x	Camera B x
0.10 mm.	0.00008 mm.	0.00006 mm.
.20	.00032	.00024
.30	.00072	.00054
.40	.00128	.00096
.50	.00208	.00149

This table is calculated for an index of refraction in the prism of $n = 1.6724$ for λ 4500. The difference is insensible in practice for other wave-lengths in the range of good focus of our plates.

METHOD OF REDUCTION

The fundamental principle of the method adopted here for the measurement and reduction of line of sight plates is that each negative shall be treated solely by itself and wholly independently of any other plate. This assumes that there is on each plate a sufficient number of well-defined comparison lines whose wave-lengths are accurately known, so that the wave-length of any point in that stellar spectrum can be determined with all necessary precision. Hence no corrections have to be applied on account of the temperature of the instrument at the time the plate was made, or to reduce the plate to the scale of some standard solar or metallic spectrum plate. It may be objected that with so stable an instrument as the Bruce spectrograph, the dispersion formula should be the same for all plates taken at the same temperature; hence always for the whole series of plates taken on a given night. This is readily admitted, but in practice the time spent in computing the Hartmann dispersion formula for each plate, with the use of the "Brunsviga" calculating machine, is no greater than that spent in adapting to a given formula the micrometer settings for each plate.

The three lines of the comparison spectrum taken for the standards in determining the constants, s_0, c, and λ_0, of the simple Hartmann formula

$$\lambda = \lambda_0 + \frac{c}{s - s_0}$$

are selected on the basis of their sharpness on the negative and their proper spacing near the two extremities and center of the measured portion of the plate. The correction for curvature is first applied to the mean of the eight settings on each of the lines of the comparison spectrum. (In some cases the correction for curvature has been applied in kilometers to the final mean of the radial velocities determined from the different star lines.) Then the wave-lengths of all the lines measured in both star and comparison spectrum are computed by the formula. In making the measurements the best (most sharply defined, and for solar stars simplest) star lines were selected, without reference to their occur-

[3] "The Curvature of the Spectral Lines in the Spectroheliograph," *Astrophysical Journal*, Vol. XI (1900), pp. 309-11.

rence in the comparison spectrum, provided only that their wave-lengths in the laboratory or in the solar spectrum are known. In every case where possible the nearest good comparison line to the selected star line is also measured. The second column of the detailed measurements, pp. 18 ff. and 33 ff., contains the computed wave-lengths. The differences between these computed values and the known wave-lengths of the comparison lines (as given in Rowland's tables for the solar spectrum) are now given in the third column as "Correction to Comp. Lines." Aside from the accidental errors of the settings, these indicate the departure of the formula from an exact representation of the wave-lengths. The corresponding corrections for the intervening star lines are interpolated between the appropriate values for the adjacent comparison lines, and are given in the fourth column.

The fifth column is entitled "Wave-length in Sun" in the case of plates of the Moon and solar stars, and is taken directly from Rowland's table. Where it is evident that two (or more) solar lines, too close to be separated by the spectrograph, have blended together in forming the line seen on the plate, the wave-length given is the result of the combination of Rowland's values of the constituent lines, with weights proportional to the estimates of their intensities in Rowland's table. A list is given below of the blends thus formed which occur in these measures.

In case of the stars of the *Orion* type the fifth column is entitled "Normal Wave-Length," and gives the best values we have been able to find for the laboratory or other determinations of the wave-lengths of the lines in question. Details as to these lines and the authorities for the wave-lengths are also given below.

The next column contains the displacement, or difference between the normal wave-length and the measured wave-length, after the latter has been corrected by the amount given in the fourth column. From the displacement the corresponding radial velocity for each star line is readily determined from our tables, computed with a value of the velocity of light of 299,860 km. per second.

In the case of stars of the *Orion* type, where the stellar lines vary greatly in their degree of diffuseness and consequent difficulty of accurate bisection, the observer assigns an arbitrary weight to the lines, which is given in the last column of the tables of measures. This weight is not assigned after an examination of the accordance of the settings, but commonly immediately upon making the first setting, and it represents the relative certainty that the observer felt as to his estimate (*Auffassung*) of the center of the line. When the observer gave a different estimate of weight in the two positions of the plate (violet toward left and violet toward right), the lower weight was taken. Inasmuch as the *Auffassung* is for such ill-defined and diffuse lines wholly a matter of individual psychology and physiology, the weights assigned to the same line on the same plate by the two observers may differ very considerably. To the same line on different plates of the same star quite different weights may be given by the same observer, since the conditions of exposure and development, and consequent intensity of the negative, never repeat themselves precisely.

The weighted mean of the determinations of velocity for all the lines is used as the radial velocity from that plate by that observer, but the unweighted mean is also given, for comparison, at the foot of column 7. These means were taken on the original reduction sheets where the computations were carried to 0.01 km., and hence may differ slightly from the means of the values when rounded to tenths as printed. Where several star lines could be measured, the difference between the weighted and simple mean is slight.

Attention may here be called to the entirely independent character of the measurements of the two observers on the same plate. The star lines measured and the comparison lines chosen as standards depend wholly upon the observer's judgment while the plate is under the microscope. The generally satisfactory accordance of the results for the same plate is evidence that the large discrepancies arising from the excessively diffuse and difficult character of some of the individual star lines are fairly well balanced in the effect on the result.

SOURCES OF ERROR

The sources of error in this work that most naturally suggest themselves may be classified as follows: (1) those due to the spectrograph; (2) those due to the measuring instrument; (3) those due to the observer or the mode of reduction; (4) those depending upon assumed physical conditions in the stellar and terrestrial sources of light. We proceed to enumerate under these heads the points which the experience of ourselves and others, with this and other instruments, has shown to be most open to error.

1. (*a*) *Flexure of the spectrograph and inadequate support of the prisms.*—This serious source of error, which was in evidence with the spectrograph first used with the forty-inch refractor, was fundamentally in mind in the design and construction of the Bruce spectrograph. It was accordingly made more rigid than any previous instrument of the kind, principally with steel construction, and we have detected no evidences whatever of error in this respect during a year's use of the spectrograph.

(*b*) *Imperfection of prisms.*—The experience with the first set of prisms supplied for the Bruce spectrograph, which has been recounted in the article by Frots already cited, gave us special reason for caution in respect to the homogeneity of the glass of the prisms. The surfaces, by the Brashear Company, easily fulfil all the requirements, as was also true of the first set. The numerous tests in the summer of 1901 did show that there was a slight difference in the performance of the thick and thin halves of the prisms, and that the definition was slightly improved by reducing the aperture to one-half. The gain in sharpness of the lines was not sufficient, however, to justify the loss of light, and the full aperture of 51 mm. of the collimated beam has been regularly used. The effect must be a slight broadening of the lines of the stellar spectrum and of the comparison spectrum, and hence the result upon the determination of the radial velocities should be very small, increasing the accidental errors but not producing systematic ones. It is not possible to use lines as close together in stellar spectra of the solar type as could be done with perfect prisms, but the effect on such "blends" would be accidental and not systematic.

(*c*) *Variations in the temperature of the prisms during exposure.*—This source of error is fully suppressed by the temperature case and electric heating. Although the control is not automatic the observer has little difficulty in maintaining the temperature of the air about the prisms within a range of 0°.2 C. during a winter night. In one respect our arrangements are not perfected in regard to temperature. When the dome is opened for solar observations during a considerable part of the day, the temperature in the spectrograph necessarily rises much higher than the normal value for the night, and consequently the temperature inside the glass of the prisms will be falling during the latter part of the afternoon and early evening. It would be desirable to have means for keeping the temperature of the spectrograph as low during the day as it is likely to be at night. However, as the exposures for the comparison spectrum are symmetrical with respect to the star exposure (except in the case of a few of the earlier plates), the effect of a lack of perfect uniformity in the temperature within the prisms will be to broaden the lines of the two spectra alike and to produce no systematic errors in radial velocities.

(*d*) *Behavior of lens of Camera B.*—The irregularly recurring astigmatism of this lens, mentioned on page 4, opens a possibility of systematic error. The effect generally is to produce a slight shading or fringe on the more refrangible side of the lines, which is more evident for the emission lines of the spark spectrum than for the absorption lines of the stellar spectrum. Hence there would be a tendency to make the settings too far toward the violet on the spark lines, which would yield too large a positive radial velocity for a stellar spectrum made when the lens was in the disturbed condition. We have always intended to use Camera A when B was thus affected, and to measure no B plates showing unsymmetrical comparison lines. If it has occurred that this condition was not noticeable though present, there may be a slight systematic effect on some of the B plates, but it does not appear on comparing the values obtained with the two cameras.

(*e*) *Adjustment of spark apparatus.*—The proper adjustment of the source of the comparison spectrum so that the collimator lens shall be fully and uniformly illuminated by it, is one of the most essential conditions in the use of the spectrograph. The angular apertures of the mirror first used for projecting the image of the spark upon the slit, and of the lens later substituted, were both more than twice as great as that of the collimator lens as seen from the slit. Within this latitude for maladjustment the position of the spark image (purposely somewhat out of focus) could be checked by direct observation of the polished jaws of the slit, or by the symmetry of the illumination of the double window as seen from behind the slit—both of which modes of observation are made possible by the arrangement of the guiding apparatus. On unscrewing the guiding telescope the collimator lens can be viewed directly by the light reflected from the first surface of the first prism, and the equality of its illumination tested while the spark is in action. The method of placing a photographic plate immediately over the lens has proved thoroughly satisfactory and more trustworthy than the visual method. It is not impossible that some of the early plates taken when the mirror was used may be open to danger of partial maladjustment of the spark; but if so, this should show in the control plates of Moon and stars (pp. 18 to 32), and there is no evidence of discrepancies which are not wholly within the range of the errors of observation (measurement).

2. *Errors due to the measuring instrument.*—The only source of error here of consequence lies in the screw. Optical distortions are not to be feared in the microscope, as only the center of the field is used and the recticle is fixed. It has a slight adjustment in position angle, so that the threads can be made parallel to the lines of the spectrum, even if the latter are not absolutely perpendicular to the length of the spectrum. A preliminary examination of the periodic errors of the screw showed that they were not large enough to require correction in the case of the *Orion* type stars, upon whose broad lines the errors of setting are necessarily large. They are, however, of a magnitude sufficient to affect the velocities derived from the sharp lines of solar stars. It has not been permissible, however, to delay this publication long enough to include them in our reductions, although a large part of the necessary observations have recently been made for both measuring machines.

It therefore remains to examine the probable effect of these errors upon the control plates. Measurements with machine G 2 (used by Adams) of a fixed distance on a glass scale, distributed over the part of the screw actually used, indicated a maximum departure from the mean of $\pm 2\mu$. If a star line were actually affected by this amount, the error in the velocity from that line would be about 2.6km. for B plates or 3.2km. for A plates. But the average departure would not exceed one-half of this, and in the best part of the screw it would not be over one-fourth. In the case of plates of the Moon a considerable number of the lines measured are also present in the comparison spectrum, so that the settings are made at practically the same part of the screw, and the periodic errors would be without effect. Since the plate is measured in both directions, starting at different readings of the head, the resulting error will be reduced by one-half on the average, but cannot be increased. Probably the effect on the velocity for the average line will not exceed three- or four-tenths of a kilometer, and as the mean velocity depends upon more than ten lines, it seems safe to believe that the radial velocity of the Moon or solar star from that plate will not be in error by over 0.1km. on account of periodic errors of the screw. The progressive errors are quite negligible.

For machine G 1 (used by Frost), with which comparatively few of the control plates were measured, the maximum screw errors are somewhat less, not exceeding $\pm 1.5\mu$. The effect on the radial velocities measured will doubtless not exceed 0.1km.

In these machines some changes have been made, tending to remove the slight amount of lost motion noticed earlier. The weights taking up the lost motion were somewhat increased. As all settings have uniformly been made in alternate directions there does not seem to be reason for fear of uncertainty in the measures on this account.

3. (*a*) *Errors due to the observer.*—Measurements of negatives under the microscope are doubtless liable to a variety of subjective errors, which should be more constant than in case of visual measurements of a similar class at the telescope. The one most familiar is that of the different habit of setting upon the dark and light lines on the negative. The process is clearly quite different in placing a dark line of the reticle, or "thread," on the center of a white line in the stellar spectrum from that in bisecting the dark comparison line with the dark "thread." The former is the easier and surer process, although the experienced observer doubtless has his habit of setting too far toward the right or toward the left, though perhaps very slightly. In the more difficult process of centering black upon black the error is greater, and probably for most observers is a function of the intensity or size of the dark line. But this personality error is largely eliminated by the regular practice of reversing the plate under the microscope and remeasuring. Measurements by Frost in 1899 upon a positive of a plate of *Polaris* yielded the same difference for violet to left—violet to right as did the measures upon the negative, but with the sign reversed. The numerical value of this difference has been quite constant and large for Frost, for B plates about 4km., in the sense that a plate measured with violet to left would require a correction of −2km. For Adams the whole amount is about 1.7km. and the sign opposite, so that a plate measured with violet to left would require a correction of about +1km.

(*b*) *Errors due to the mode of reduction.*—It might be thought that an improvement would have been made in the reduction process by using the exponential form of Hartmann's formula. While the wave-lengths would thus have been a little more closely obtained, the gain would not have offset the increased expenditure of time. As a matter of fact, with the method used of correcting the formula at every point where a comparison line was measured (which occurred as near as possible to the position of each star line), the accuracy of the formula is of small consequence, and almost any formula could have been employed, provided only that the differences for short stretches of spectrum could be regarded as linear.

Probably it would also be regarded by some as advantageous to smooth out the accidental errors of settings on the comparison lines by a curve. We have feared the arbitrariness of curve drawing, and have ordinarily thrown the accidental errors upon the star line, although where two comparison lines have fallen close together, with no star line intervening, the mean correction has commonly been taken, valid for the mean wave-length. In a few cases of extrapolation beyond the limits of the formula there has been a slight uncertainty as to the proper correction to the "wave-length by formula" of the stellar lines, but the effect would be small.

To conform with Rowland's tables the reductions have been carried out so as to be accurate to the thousandth of the tenth-meter. This gives a specious precision to the displacement for the lines whose wave-lengths have been measured only to the hundredth. In general we should not wish to place any reliance on anything less than the whole kilometer for the best measurable of the *Orion* type stars; and in view of all the sources of error now discussed, many of them not correctable in our present state of knowledge, almost the same can be said for the stars of the solar type.

It has not been possible for us to give the time necessary for the duplicate calculation of the numerical quantities involved in our detailed reductions, so that errors doubtless occur. In general these must be small, however, as those involving an amount as large as 0.02 or 0.03 tenth-meters would be noticeable as breaking the smoothness of the run of the "corrections to comparison lines;" and all such cases have been checked. It does not seem to us likely that these errors in computation can affect the mean value of the radial velocity from any one plate by more than a very small fraction of a kilometer.

In the computation of some of the plates measured by Frost assistance was received from Miss Anne S. Young, research assistant at the observatory during the summer quarter of 1902.

4. *Errors due to assumptions as to physical conditions.*

(*a*) In adopting the wave-lengths given in Rowland's table for the solar spectrum for our spark lines, we obviously assume that the conditions in the sun's reversing layer and in the spark are

sufficiently alike as to pressure and otherwise to justify the procedure. Determinations of the wave-lengths of the lines in the spark spectrum of titanium, of an order of accuracy equal to that of Rowland's table, are not available, and there would perhaps be quite as much assumption in using arc wave-lengths as solar wave-lengths. It is a fact that the relative intensities of the *Ti* spark lines on our plates follow much more closely the estimates in Rowland's table than they do Hasselberg's estimates for the arc spectrum of *Ti*. This indicates that the principal dark lines in the solar spectrum due to titanium are enhanced lines, and it suggests that the conditions may have some degree of similarity in sun and spark.

Jewell has found a slight systematic difference between arc and solar wave-lengths,[4] the metallic lines being relatively displaced toward the violet by something like 0.01 to 0.02 tenth-meters. Correction was made for this in the determination of Rowland's standards,[5] as its origin was then supposed to be instrumental. Jewell interprets it as an effect of the density and pressure at the level in the solar atmosphere at which the particular line is produced. The direction of the displacement would indicate a greater pressure in the solar atmosphere than in the arc. If the spark lines are also shifted toward the red relatively to the arc, the effect upon our measured radial velocities might be diminished. The large shifts of this sort described by Haschek[6] were not confirmed in amount by preliminary experiments made at the Yerkes Observatory by Dr. N. A. Kent, who found shifts of only about the order of those measured by Jewell. In the present state of our knowledge we therefore cannot say with any certainty how much our results are affected by the use of solar wave-lengths for our *Ti* lines; but presumably by an amount corresponding to less than 0.02 tenth-meters, or about 1.4 km., and perhaps very much less. The sign, moreover, cannot be given.

(*b*) The assumption that stellar wave-lengths are the same as those for the corresponding elements in the laboratory, if incorrect, also renders our measurements of velocity liable to some uncertainty, at present indeterminate. There are some instances where a distinct difference in wave-length is indicated. The most conspicuous case is that of the line always attributed to magnesium, at λ4481. Laboratory determinations of this diffuse line in the spark spectrum (obtainable also in the rotating arc) give a value of about λ4481.32,[7] while the value obtained by Adams[8] from a number of plates of *Sirius*, and of *γ Geminorum* and *θ Leonis*, is 4481.40. The latter value also satisfies the measurements for most of the stars included in this paper, and it has uniformly been used, as we are not prepared to adopt the radical procedure of employing a still different value for the three or four stars for which an intermediate value of this wave-length would perhaps give velocities more accordant with those from other lines. The wave-length found for this line by Scheiner[9] in the spectra of eighteen stars of the first type is 4481.44 (Rowland's scale).

Finally, in respect to wave-lengths, it should perhaps be mentioned that a relative error of ±0.01 tenth-meter in Rowland's value for a line would produce an error in our velocity for that line of ± 0.7km. Probably errors in Rowland's table as large as that are very rare, and Rowland may underestimate the accuracy of his standards in his statement "From the tests I have made on my standards, I am led to believe that down to wave-length 7000, a correction not exceeding ± 0.01 division of Ångström (1 part in 500,000), properly distributed, would reduce every part to perfect relative accuracy."[10]

Of course the precision of the absolute wave-lengths of Rowland's table does not affect our results.

[4] *Astrophysical Journal*, Vol. III (1896), pp. 89-113.

[5] H. A. ROWLAND, "On a Table of Standard Wave-Lengths of the Spectral Lines," *Memoirs of the American Academy of Arts and Sciences*, Vol. XII (1896), No. 2.

[6] *Astrophysical Journal*, Vol. XIV (1901), p. 184.

[7] HENRY CREW, *ibid.*, Vol. XVI (1902), p. 247.

[8] *Ibid.*, Vol. XV (1902), p. 216.

[9] *Publicationen des Astrophysikalischen Observatoriums zu Potsdam*, Bd. VII (1895), Theil II, p. 315.

[10] *Memoirs of the American Academy of Arts and Sciences*, Vol. XII, No. 2, p. 110.

WAVE-LENGTHS OF THE PRINCIPAL STAR LINES USED

The tables which follow contain all of the more important star lines which we have employed, with the exception of such lines as occur in stars of the solar type of spectrum and are not blends. As the wave-lengths of the latter are taken directly from Rowland's table of solar spectrum wave-lengths, it has not seemed necessary to repeat them here. For the sake of completeness the value of a displacement of one tenth-meter in kilometers per second for the various wave-lengths given is included in the tables.

(*a*) *Blends.*—While we have endeavored, as far as possible, in our measures of plates of the Moon, planets, and stars of the solar type of spectrum, to use only single lines, it has been found impossible to avoid blended lines entirely, as some of the best lines in the spectra are of this nature. In such cases we have assigned weights to the component lines according to the intensities given in Rowland's table. This procedure is evidently rigorous for the Moon and planets, and proves satisfactory in the case of most of the stellar lines used in the solar stars we have investigated. Occasionally, however, a line of slight intensity in the Sun rises to considerable intensity in a star and materially changes the wave-length of a blended line. In such a case the change shows itself by the systematic deviation of this line from the other lines of a plate, and the line is rejected after a sufficient number of plates have shown the deviation to be unquestionably systematic.

The decision as to what intensity a line should have in order to exert an influence upon a closely adjacent line is naturally somewhat arbitrary, and depends upon the quality of the plate considered. In general, however, our experience shows that upon a plate of quality suitable for good measurement a line of intensity "0" on Rowland's scale has an appreciable influence, while fainter lines may be neglected. But this does not hold if the adjacent line is overpoweringly strong, as in such a case the strong line may stand out clearly against the fainter without being influenced by it. A case of this sort is the iron line λ 4528.798 of intensity 8 in the solar spectrum, measures of which do not indicate any disturbing effect from the several faint lines near it.

The following table contains the wave-lengths of the blended lines most frequently used. For the sake of brevity, those which have been used but rarely are not included, but the wave-lengths employed in such cases, are given in column five of the detailed statement of the measurements on pp. 18 ff. and 33 f.:

Elements	Wave-Length	No. of km. per tenth-meter	Elements	Wave-Lengths	No. of km. per tenth-meter
Ti; Fe	4427.420	67.73	*Cr, Mn; Ti*	4501.422	66.61
Fe; Ti	4434.021	67.63	—, —	4515.475	66.40
Ca; Fe	4435.184	67.61	*Fe?; —; Ti*	4522.853	66.30
Zr-Fe; Ti?	4450.597	67.37	—; *Fe*	4525.285	66.26
Mn; Ca	4456.030	67.29	—; *Cr; Fe*	4526.644	66.24
Ti, V, Zr; Mn	4457.656	67.27	*Ti; —*	4527.518	66.23
V; Mn; —	4460.460	67.23	*Ti-Co; —*	4534.168	66.13
Ni; Fe	4466.701	67.13	*Fe; Ti-Co*	4549.767	65.91
Fe; Mn; Ni?	4472.958	67.04	*Cr; Co-Fe*	4565.750	65.68
Fe; Ag	4476.214	67.00	*Ca; Co, Fe*	4581.634	65.44
—, *Fe; Fe*	4482.376	66.90	*Cr; Fe*	4611.455	65.02
Cr; Zr	4497.046	66.68	*Fe; Cr, La*	4613.465	64.99

(*b*) *Oxygen and nitrogen lines.*—The wave-lengths of the following oxygen and nitrogen lines occurring in the spark spectrum of air have been determined by us on plates taken with the concave grating, with various elements serving as the spark electrodes. The values have been published in the *Astrophysical Journal*, Vol. XVI (1902), pp. 118-20. The identifications are those of Neovius.[11]

[11] *Bihang till K. Svenska Vet.-Akad. Handlingar*, Vol. XVII, 1891.

Element	Wave-Length	No. of km. per tenth-meter	Element	Wave-Length	No. of km. per tenth-meter
O	4317.272	69.46	*N*	4601.632	65.17
O	4319.762	69.41	*N*	4607.305	65.08
O	4345.677	69.00	*N*	4614.033	64.98
NO	4348.134	68.96	*N*	4621.548	64.88
O	4349.541	68.94	*N*	4630.703	64.75
O	4351.495	68.91	*O*	4638.937	64.64
O	4367.012	68.66	*O*	4641.886	64.60
O	4415.076	67.92	*N*	4643.244	64.58
O	4417.121	67.88	*O*	4649.250	64.49
NO	4447.163	67.42	*NO*	4650.925	64.47
O	4591.066	65.31	*O*	4661.728	64.32
O	4596.291	65.24			

(*c*) *Silicon lines.*—The following wave-lengths of the three silicon lines used by us are those given by Exner and Haschek,[12] who used the spark passing between electrodes of metallic silicon as the source of spectrum. The occurrence of these lines in the spectra of stars resembling *β Crucis* was observed by McClean and by Gill, and their origin was traced by Lunt in a careful series of experiments at the Cape Observatory. It is unfortunate that the wave-lengths, particularly that of the third line, cannot be more accurately assigned. This is doubtless due to their diffuse character in the spark spectrum, which was remarked by Exner and Haschek.

Wave-Length	No. of km. per tenth-meter
4552.75	65.87
4567.95	65.64
4574.9	65.54

(*d*) *Magnesium lines.*—The magnesium line at λ4352 occurs in the Sun, and accordingly its wave-length is given by Rowland. The wave-length of the line at λ4481 has been determined by Adams from measures of the spectra of stars of Vogel's type Ia,[13] and is discussed more fully on p. 13.

Wave-Length	No. of km. per tenth-meter
4352.083	68.90
4481.400	66.91

(*e*) *Helium lines.*—The wave-lengths of the helium lines which we have used are those given by Runge and Paschen.[14] The double lines at λ4471 and λ4713 have been blended, the weights assigned to the components being 6 and 1 for λ4471, and 3 and 1 for λ4713. (The intensities given by Runge and Paschen are respectively 6 and <1 and 3 and <1.)

Wave-Length	No. of km. per tenth-meter
4388.100	68.33
4437.718	67.57
4471.676	67.06
4713.308	63.62

[12] "Note on the Spectrum of Silicon," *Astrophysical Journal*, Vol. XII (1900), pp. 48, 49.

[13] "Some Results with the Bruce Spectrograph," *ibid.*, Vol. XV (1902), pp. 214-17.

[14] "On the Spectrum of Clèveite Gas," *ibid.*, Vol. III (1896), pp. 1-28.

JOURNAL OF OBSERVATIONS

The extract given below from the regular observing journal of the Bruce spectrograph furnishes the observational data for all of the plates discussed in the present article. The principal omissions are the numerical values of the focal settings of the collimator and camera, and of the focal scale of the telescope, upon which the position of the slit in the plane of the forty-inch objective depends. The last varies with the temperature, and its value is furnished by a table constructed from Barnard's results for the variation of the focal length of the telescope with the temperature. The collimator setting has been changed but once, and then on the occasion of the substitution of the "isokumatic" lens, to which reference has already been made, for the lens previously in use. The focal setting of Camera A has been kept practically unchanged, repeated tests during the severe weather of the winter showing no appreciable variation in focus. The recementing of the objective of Camera B has, however, necessitated changes of its focal setting on several occasions, as appears in the Remarks.

Most of the columns in the journal are self-explanatory. The length of exposure in seconds for the comparison spectrum is indicated by the number following the symbol of the element employed: thus "*Ti* 6" denotes an exposure of the titanium spark for six seconds. The time in reference to the star exposure at which the comparison spectrum is photographed is given in the two columns headed "Beginning" and "End," while an intermediate entry refers to the middle of the star exposure unless the time is expressly stated. The number of turns of self-induction in the secondary circuit of the spark coil is also given. The first (*i*) of the temperature entries always refers to the temperature inside the prism box, the second (*o*) to the temperature inside the large aluminium case which covers the spectrograph. The middle of the star exposure is given in Central Standard time.

In the case of nearly all of the exposures entered in the list below, the labor of guiding has been shared equally by the observer and Mr. F. R. Sullivan, engineer in charge of the telescope, to whom we are much indebted for this efficient assistance.

Object	Series and Number	Date	Middle of Exposure	Duration	Hour Angle at End	Slit Width	Comparison Beginning	Comparison End	Self-Induction	Temperature Beginning *i*	Temperature Beginning *o*	Temperature End *i*	Temperature End *o*	Seeing	Observer	Remarks
		1901	h. m.	m.	h. m.	mm.			turns							
α *Tauri* ..	B191	Sept. 4	14 01	25	E 3 15	0.028		*Ti* 6	350	26.2	26.2			Poor	A	New diagonal prism in spark apparatus
β *Orionis* ..	A207	"	15 43	8	E 2 25	0.028		*Ti* 6	"	26.3	26.4			Fair	A	
ε *Orionis* ..	A208	"	16 10	25	E 2 10	0.028	*Ti* 6		"	26.4	26.4	26.4	26.4	Fair	A	
γ *Pegasi* ...	A215	Sept. 5	15 28	45	W 2 45	0.045	*Fe* 48, *Ti* 4, *He* 5		350; 850	25.5	25.4	25.4	25.3	Fair	F	
γ *Pegasi* ...	A218	Sept. 6	11 07	55	E 1 35	0.028	*Ti* 6, *He* 5		" "	27.2	27.4	27.2	27.2	Fair to good	A	
γ *Orionis* ..	A224	Sept. 11	15 32	9	E 2 12	0.050	*Fe* 55, *Ti* 3, *He* 3		" "	16.7	16.5			Poor	F	
ζ *Persei* ...	A226	Sept. 12	12 04	62	E 3 35	0.050	*Ti* 7, *He* 5		" "	16.4	16.2	16.4	16.2	Poor	A	40-inch objective found to be covered with light dew
γ *Pegasi* ...	A233	Sept. 18	8 50	44	E 3 00	0.035	*Ti* 6, *He* 7		" "	12.0	12.1	12.0	12.1	Good	A	
ζ *Persei* ...	A235	"	12 26	55	E 3 00	0.035	*Ti* 6, *He* 6		" "	12.0+	12.0	12.0+	12.1	Good	A	
β *Orionis* ..	A237	"	14 52	8	E 2 15	0.035	*Ti* 6, *He* 6		" "	12.0+	12.2			Fair	A	
β *Orionis* ..	A243	Sept. 20	15 42	7	E 1 20	0.038	*Ti* 8, *He* 8		" "	11.1	11.4			Fair	A	
κ *Orionis* ..	A244	"	16 13	25	E 1 10	0.038	*Ti* 8, *He* 8		" "	11.2	11.4	11.2	11.4	Good	A	
γ *Pegasi* ...	A245	Sept. 26	8 05	55	E 3 10	0.038	*Ti* 10, *He* 10		" "	22.4	22.6	22.4	22.4	Fair	A	
Moon.....	A246	"	8 48	12	E 1 56	0.023	*Ti* 12, *Fe* 88		350	22.4	22.3			Fair	A	
β *Orionis* ..	A249	"	14 54	8	E 1 45	0.038	*Ti* 10, *He* 11		350; 850	22.4	22.4			Poor	A	
κ *Orionis* ..	A250	"	15 26	30	E 1 35	0.038	*Ti* 10, *He* 11		" "	22.4	22.2	22.4	22.4	Poor	A	Light clouds and thick haze
ι *Herculis*.	A251	Sept. 27	8 35	80	W 4 10	0.038		*Ti* 8, *He* 9	" "	22.4	22.5	22.4	22.4	Poor	A	
Moon.....	A253	"	10 22	20	E 1 5	0.030		*Ti* 7, *Fe* 60	350	22.4	22.4	22.4	22.2	Poor	A	
γ *Orionis* ..	A258	Oct. 2	15 34	23	E 0 35	0.038	*Ti* 8, ± *He* 20 ±		350; 850	11.6	12.1	11.5	10.4	Fair; poor	F	
ι *Herculis*.	A260	Oct. 3	9 30	80	W 5 25	0.038		*Ti* 7, *He* 17	" "	9.9	9.9	9.9	9.8	Poor to fair	A	
ε *Cassiop*..	A261	"	11 15	100	E 0 45	0.038		*Ti* 7 ±, *He* 15	" "	9.9	10.0	9.9+	9.6	Good to poor	A	Spark intermittent
β *Orionis* ..	A262	"	13 26	7	E 2 45	0.038		*Ti* 7, *He* 18	" "	9.9	10.0			Fair	A	
ζ *Orionis* ..	A263	"	14 42	22	E 1 56	0.038		*Ti* 7, *He* 17	" "	9.9	9.6			Poor	A	Thick haze
γ *Pegasi* ..	B194	Oct. 16	12 46	82	W 3 3	0.035	*Ti* 12, *He* 25		" "	7.2	6.9	7.3	6.8	Poor; bad	F	Camera lens recemented by Brashear
β *Orionis* ..	B195	Oct. 17	12 48	9	E 2 15	0.035		*Ti* 12, *He* 30	" "	5.5	5.5			Fair	A	
κ *Orionis* ..	B196	"	13 24	35	E 2 15	0.035	*Ti* 11, *He* 28		" "	5.5	5.6	5.5	5.4	Poor	A	
β *Can.Maj.*	B200	"	16 10	35	0 00	0.035		*Ti* 12, *He* 30	" "	5.5	5.4	5.5	5.6	Poor	A	
Moon.....	B202	Oct. 18	7 30	40	W 3 20	0.035		*Ti* 12 ±, *He* 60	350	12.1	12.3	12.25	12.35	.....	F	
ι *Herculis*.	B203	"	9 27	150	W 7 00	0.035	*He* 30 ±, *Ti* 7 at 9:10		"	12.25	12.3	12.25	12.15	Very bad	F	
β *Orionis* ..	B207	"	14 07	24	E 1 00	0.035		*Ti* 15, *He* 90	"	12.1	11.8	12.25	12.2	Bad	F	
κ *Orionis* ..	A274	Oct. 23	13 26	27	E 1 47	0.035		*Ti* 9, *He* 40	"	19.5	20.3			Fair	A	New windows in occulting bar; mirror used for spark
ε *Cassiop*..	A275	"	14 35	70	W 3 40	0.048		*Ti* 6, *He* 40	"	19.5	20.8	19.5	19.3	Fair	A	
ε *Cassiop*..	A278	Oct. 25	8 08	100	E 2 45	0.038		*Ti* 12, *He* 120	"	12.7	12.8	12.7	12.7	Fair	A	
ζ *Cassiop*..	A281	Oct. 31	7 50	90	E 1 15	0.050		*Ti* 14, *He* 50	50; 350	14.0	14.1	14.0	13.8	Good	A	
β *Orionis* ..	A284	"	13 58	7	E 0 25	0.050		*Ti* 14, *He* 55	" "	14.0	13.6			Good	A	
κ *Orionis* ..	A285	"	14 24	22	E 0 20	0.050		*Ti* 14 ±, *He* 55	" "	14.0	14.1	14.0	13.8	Fair	A	Spark intermittent
Moon.....	A286	"	15 00	17	.....	0.050		*Ti* 14, *Fe* 100	50	14.0	14.3			.....	A	
β *Can.Maj.*	A287	"	15 35	22	W 0 20	0.050		*Ti* 14, *He* 50	50; 350	14.0	14.3	14.1	14.2	Fair	A	
β *Can.Maj.*	A293	Nov. 1	15 26	44	W 0 25	0.050		*Ti* 14	50	11.4	11.7	11.7	11.9	Very good	F	
ζ *Cassiop*..	B211	Nov. 7	8 43	85	0 00	0.038		*Ti* 5	"	3.2	3.1			Excellent	FA	Camera lens recemented

Object	Series and Number	Date	Middle of Exposure	Duration	Hour Angle at End	Slit Width	Comparison Beginning	Comparison End	Self-Induction	Temperature Beginning t	Temperature Beginning o	Temperature End t	Temperature End o	Seeing	Observer	Remarks
		1901	h. m.	m.	h. m.	mm.			turns							
β *Orionis*..	B213	Nov. 7	12 06	9	E 1 45	0.038		*Ti* 7	50	3.3	3.0	3.3	2.8	Excellent	FA	
β *Can. Maj.*	B215	"	15 00	35	W 0 10	0.038		*Ti* 6½	"	3.2	3.4	3.2	3.0	Excellent	FA	
ζ *Persei* ...	B218	Nov. 8	10 33	80	W 0 10	0.038		*Ti* 7	"	4.9	5.2	5.1	5.2	Good; hazy	A	Temperature rising
β *Orionis*..	B220	"	14 06	9	E 1 15	0.038		*Ti* 7	"	5.1+	4.8			Fair	A	
γ *Orionis*..	B221	"	14 39	25	W 0 15	0.038		*Ti* 7 ±	"							
Venus	B224	Nov. 13	h. m.	m.	W 0 45	0.038	*Ti* 7		"	5.1	5.4	5.1	4.9	Good	A	
ε *Orionis*..	B228	"	5 34	17	W 2 45	0.038		*Ti* 14	"	8.5	8.5	8.5	8.2	Fair	F	Occulting bar readjusted
β *Orionis*..	B231	Nov. 14	13 50	28	E 0 15	0.038		*Ti* 14	"	7.6	6.6	7.7	7.0	Poor	F	
ζ *Persei*...	B232	"	13 19	9	E 0 10	0.038		*Ti* 12	"	9.0	9.0	9.0+	9.2	Good	A	
α *Arietis*...	B233	Nov. 15	14 04	62	W 2 48	0.038		*Ti* 7	"	9.0	9.2	9.0	8.8	Fair	A	Stopped by clouds
β *Orionis*..	B237	"	8 36	28	E 1 25	0.038		*Ti* 12	"	−1.1	−1.1	−1.1	−1.2	Good	F	
γ *Pegasi*...	B246	Nov. 27	12 52	9	E 0 30	0.038		*Ti* 11	"	−0.2	0.0	−0.4	−0.7	Good	F	
ζ *Cassiop*..	B248	"	6 11	83	E 0 45	0.025		*Ti* 11	"	0.8	1.0	0.8	0.4	Good to fair	FA	Clouds at end
β *Orionis*..	B252	"	10 48	112	W 3 45	0.025	*Ti* 4	*Ti* 6½	"	0.9	0.9	0.9	0.3	Good	F	
Moon	B254	Dec. 18	15 22	14	W 2 50	0.025		*Ti* 10	"	0.9	0.4	0.9	0.5	Good	F	
β *Orionis*..	B257	"	7 36	27	.....	0.025		*Ti* 15	"	−15.7	−15.7	−15.6+	−15.8	4; 3	A	Hereafter transpar'ncy and seeing will be given in the order named on a scale of 0 to 5, 5 denoting perfect conditions
β *Orionis*..	A297	Dec. 19	12 12	8	W 1 00	0.038		*Ti* 15	"	−15.8	−15.6			4; 2	A	
β *Orionis*..	B261	Dec. 31	11 34	13	W 0 30	0.038		*Ti* 7	"	−13.6	−13.0			1-3; 2	A	
γ *Orionis*..	B262	"	9 12	8	E 1 10	0.025		*Ti* 12	"	−2.0	−2.3			4; 4	A	
		1902	9 39	25	E 0 45	0.025		*Ti* 10	"	−1.9+	−1.6	−2.0	−2.2	4; 4	A	
β *Orionis*..	A300	Jan. 4	11 44	10	W1 40	0.025		*Ti* 9	"	−6.6	−6.4			4; 2	A	
Venus	A303	Jan. 8	5 28	17	.....	0.025		*Ti* 12	"	+3.3	+3.7			4; 2	A	
β *Orionis*..	A306	"	12 15	8	W 2 28	0.025		*Ti* 9	"	3.6	3.6			4; 1	A	
β *Orionis*..	B270	Jan. 9	8 41	8	E 1 10	0.025		*Ti* 11	"	3.2	3.2			4; 4	A	
α *Tauri*....	B275	Jan. 16	8 15	25	E 0 20	0.020		*Ti* 27	350	−3.3	−3.2	−3.4	−3.6	4; 4	A	
β *Orionis*..	B277	"	11 02	8	W 1 50	0.020		*Ti* 22	"	−3.3	−3.4	−3.4	−3.6	4; 4	A	
β *Orionis*..	B282	Jan. 24	6 50	10	E 1 55	0.025		*Ti* 20	"	−3.8	−3.9			4; 4	A	
ζ *Draconis*	B290	Feb. 3	16 24	83	E 3 00	0.040	*Ti* 9 at 16:07	*Ti* 6	"	−13.7	−13.4	−13.7	−13.3	4; 4-3	A	
β *Orionis*..	A312	Feb. 10	8 54	10	W 1 15	0.020		*Ti* 30	"	−7.6	−7.4			4; 4	A	
ζ *Draconis*	A314	"	16 12	60	E 2 50	0.040	*Ti* 7	*Ti* 7	"	−7.6	−7.8	−7.5	−7.4	4-3; 4	A	
Moon	A320	Feb. 19	7 20	37	E 2 20	0.033	*Ti* 11	*Ti* 12	"	−5.3	−5.0	−5.3	−5.1	4; 4	A	
ζ *Draconis*	A324	"	14 33	42	E 4 10	0.045	*Ti* 6 at 14:20;	*Ti* 6 at 14:45	"	−5.2	−5.0	−5.2	−5.5	4; 4	A	New isokumatic collim. lens used from this point on
τ *Herculis*.	A325	"	15 33	55	E 2 05	0.050	*Ti* 5	*Ti* 3	"	−5.2	−5.6	−5.2	−5.4	4-1; 4	A	
β *Orionis*..	A330	Mch. 3	7 44	14	W 1 30	0.025		*Ti* 25	"	−2.8	−2.8			2; 4	A	Sky very thick
α *Boötis*...	B293	Mch. 12	12 13	16	E 2 20	0.020		*Ti* 35	"	3.5	3.5			4; 3	A	
τ *Herculis*.	B295	"	16 09	47	E 0 20	0.045	*Ti* 12	*Ti* 10	"	3.5	3.4	3.5	3.3	4; 4	A	
κ *Orionis*..	B297	Mch. 13	8 29	30	W 2 30	0.040	*Ti* 10	*Ti* 11	"	9.3	9.3			4; 1-2	A	Seeing very bad
ε *Orionis*..	B298	"	9 11	35	W 3 25	0.040	*Ti* 10	*Ti* 10	"	9.3	9.4	9.3	9.2	3; 1	A	
γ *Orionis*..	B299	"	9 53	30	W 4 15	0.040	*Ti* 10	*Ti* 11	"	9.3	9.4			3; 1	A	
α *Boötis*...	B300	"	11 29	24	E 3 00	0.020		*Ti* 38	"	9.3	9.8			4; 2	A	
τ *Herculis*.	B301	"	13 36	80	E 2 30	0.040	*Ti* 10	*Ti* 10	"	9.2+	9.9	9.3	9.0	4; 2	A	
α *Boötis*...	A336	Mch. 26	12 59	25	E 0 20	0.020	*Ti* 10	*Ti* 12	"	8.7	8.6	8.7	8.6	3; 2	A	Lens used in spark apparatus from this point
Moon	A337	"	14 49	35	W 0 45	0.025	*Ti* 8	*Ti* 8	"	8.6+	8.6+			3; 2	A	
α *Boötis*...	B304	April 2	9 51	22	E 3 20	0.020		*Ti* 10	"	2.0	2.3			4; 4	A	
γ *Corvi*	B305	"	10 32	30	E 0 20	0.040	*Ti* 3	*Ti* 3	"	2.0	2.1	2.0	1.8	4; 3	A	
α *Boötis*...	B311	April 3	9 57	18	E 3 15	0.020	*Ti* 11		"	4.8	5.0			4; 4	A	
γ *Corvi*	B312	"	10 32	30	E 0 30	0.040	*Ti* 3	*Ti* 4	"	4.8	4.6	4.9	5.2	4; 4	A	
τ *Herculis*.	B313	"	11 29	55	E 3 30	0.040	*Ti* 4	*Ti* 3	"	4.8	4.8	4.8	5.0	4; 4	A	
κ *Orionis*..	B315	April 9	7 47	28	W 3 35	0.038	*Ti* 3	*Ti* 3	"	8.0	8.5	8.1	8.5	3; 3	F	
ε *Orionis*..	B316	"	8 21	23	W 4 20	0.038		*Ti* 7	"			8.3	8.5	4; 4	F	
γ *Orionis*..	B317	"	9 04	27	W 5 10	0.038		*Ti* 7	"			8.4	8.6	2; 3	F	
Moon	B323	April 16	11 12	35	W 3 50	0.028	*Ti* 6	*Ti* 9 ±	"	7.4	7.4	7.4	7.4	3; 4	A	
γ *Corvi*	B324	"	12 15	35	W 2 05	0.040	*Ti* 8		"	7.4	7.4	7.4+	7.4	3; 4	A	
Moon	B328	April 19	8 40	30	E 1 00	0.028	*Ti* 4 +	*Ti* 6	"	7.8	7.8	7.8	7.6	.....	F	
η *Leonis*...	B329	"	9 43	64	W 2 10	0.040	*Ti* 3½		"	7.8	7.3	7.8	7.5	3; 2	F	
γ *Corvi*	B330	"	11 03	60	W 1 15	0.040	*Ti* 3 +	*Ti* 3	"	7.8	7.3	7.8		3-1; 2	F	Cirrus clouds
η *Leonis*...	B333	April 23	9 31	65	W 2 10	0.040	*Ti* 3	*Ti* 3	"	9.7	9.6	9.7	9.6	.....	F	
η *Leonis*...	B337	April 30	9 53	85	W 3 10	0.038	*Ti* 10		150	14.5	14.6	14.5	14.4	1;1	F	
α *Boötis*...	B342	May 7	11 17	26	W 0 30	0.023	*Ti* 4	*Ti* 3½	"	15.7	14.8	15.7	15.7	3; 2	F	
67 *Ophiuchi*	B347	May 14	13 14	114	E 0 10	0.038	*Ti* 2½	*Ti* 2½	"	11.3	11.9	11.3	10.8	2; 1	F	
ζ *Draconis*	B357	May 30	10 04	44	E 2 05	0.040	*Ti* 3	*Ti* 2	"	20.4	20.6	20.5	20.4	3-4; 4	F	Clouded over suddenly
Moon	B363	June 20	12 55	30	W 1 05	0.030	*Ti* 3	*Ti* 4	350	16.2	16.0	16.2	16.2	3; 1	A	
67 *Ophiuchi*	B369	June 25	13 41	78	W 2 50	0.040	*Ti* 2	*Ti* 1	"	17.6	18.5	17.8	17.8	2; 2-3	F	
α *Boötis*...	B371	June 26	9 30	12±	W 1 40	0.025	*Ti* 2		"	16.4	16.4			2-0; 2	A	Stopped by clouds
67 *Ophiuchi*	A346	July 7	11 32	81	W 1 25	0.035	*Ti* 6	*Ti* 4	"	28.6	29.4	28.5	28.0	4; 4	F	
ε *Delphini*.	A349	July 11	11 55	102	E 0 20	0.033	*Ti* 5		"	22.8	22.7	22.8	22.5	3; 2	F	Clouds at end
Moon	A350	July 16	8 28	40	E 0 20	0.030	*Ti* 5	*Ti* 5	"	23.4	23.9	23.6	24.2	2; 1	A	Temperature rising
ε *Delphini*.	A353	"	12 48	120	W 1 05	0.040	*Ti* 3	*Ti* 4	"	24.4	24.7	24.5	24.5	2; 2-1	A	
ζ *Cassiop*..	A355	July 22	13 10	100	E 2 20	0.038	*Ti* 35	*Ti* 25	"	20.3	20.6	20.3	19.8	2-3; 2-3	F	Ground glass screen used in front of slit for spark exposure after this date
102 *Hercu*..	A358	July 23	11 53	130	W 3 05	0.040	*Ti* 18	*Ti* 25	"	22.7	22.6	22.7	22.6	2; 3-1	A	
ε *Delphini*.	A359	"	13 59	93	W 2 25	0.040	*Ti* 20	*Ti* 30	"	22.7	22.6	22.7	22.8	2; 4	A	
ε *Delphini*.	A363	July 31	10 45	110	E 0 10	0.040	*Ti* 40	*Ti* 45	"	25.5	25.5	25.4+	25.2	3; 1-2	A	
η *Lyræ*	A365	"	14 51	102	W 5 12	0.040	*Ti* 35	*Ti* 30	"	25.5	25.4	25.5	25.2	3; 2	A	
102 *Hercu*..	B385	Aug. 11	10 10	90	W 2 20	0.038	*Ti* 25	*Ti* 25	"	17.8	17.8	17.8	17.6	4; 4	A	
γ *Pegasi*...	B396	Aug. 22	14 40	71	W 1 15	0.033	*Ti* 30, *Cr* 60	*Ti* 35, *Cr* 100	"	19.6	18.9			3; 3	F	
102 *Hercu*..	B397	Aug. 27	9 00	120	W 2 28	0.040	*Ti* 60	*Ti* 50	"	22.2	22.0	22.2	22.2	3; 3-4	A	
ε *Cassiop*..	B399	"	12 49	62	E 1 50	0.038	*Ti* 45	*Ti* 45	"	22.2	22.4	22.2	22.0	3; 3	A	
Moon	B401	"	15 47	37	E 3 25	0.038	*Ti* 40	*Ti* 45	"	22.2	22.4			3; 3	A	
102 *Hercu*..	B402	Sept. 3	9 10	150	W 3 15	0.043	*Ti* 60	*Ti* 60	"	16.8	16.9	16.8	16.4	4; 1-2	A	
ι *Herculis*.	B408	"	11 20	85	W 5 20	0.043	*Ti* 60	*Ti* 50	"	16.8	16.9	16.8	16.3	4; 2-3	A	
α *Boötis*...	A373	Sept. 6	7 43	15±	W 4 50	0.025		*Ti* 115	"	20.3	20.2			3-0; 2	A	Freq't clouds
η *Lyræ*	A379	Sept. 7	10 20	120	W 3 20	0.038	*Ti* 45	*Ti* 40	"	19.4	19.6	19.6	19.7	4; 2	F	Strong wind
Moon	B408	Sept. 13	10 13	35	W 1 32	0.038	*Ti* 40	*Ti* 40	"	12.7	12.7	12.7	12.4	3; 1	A	
η *Lyræ*	B409	"	11 57	150	W 5 35	0.043	*Ti* 40	*Ti* 30	"	12.7	13.0	12.7	13.2	3; 1	A	
γ *Pegasi*...	B419	Oct. 9	11 53	80	W 1 45	0.038	*Ti* 20	*Ti* 27	"	12.5	12.8	12.5	12.0	2-3; 2-3	F	
η *Lyræ*	B422	Oct. 15	14 12	120	W 3 45	0.040	*Ti* 20	*Ti* 20	"	15.4	15.4	15.4+	15.2	3; 3-4	A	
Moon	B423	"	15 44	30	E 1 01	0.028	*Ti* 30	*Ti* 40	"	15.4	15.4	15.4	15.3	3; —	A	
ζ *Persei*....	B424	"	16 43	60	E 2 55	0.038	*Ti* 25	*Ti* 25	"	15.4	15.4	15.4	15.4	3; 4	A	
η *Lyræ*	B427	Oct. 16	9 32	125	W 5 25	0.038	*Ti* 20	*Ti* 20	"	10.1	9.8	10.1	10.0	2; 3-2	F	Exposure cut off by clouds from 10:00-10:15
ζ *Orionis* ..	B433	Oct. 29	19 04	25±	E 1 52	0.038	*Ti* 25	*Ti* 35	"	7.6	7.8	7.7	7.9	2-0; 1	A	
ζ *Orionis* ..	B434	"	19 45	24	E 1 12	0.038	*Ti* 30	*Ti* 35	"	7.7+	7.9			3; 2	A	
ζ *Orionis* ..	B441	Oct. 30	21 19	16	W 0 27	0.038	*He* 30, *Ti* 60		"	12.7	12.5			4; 4-5	F	
Moon	B444	Nov. 6	13 38	40	W 2 54	0.033		*Ti* 60	"	7.1	7.1	7.1	6.9	3; —	F	
ε *Can. Maj.*	B451	"	21 47	30	0 00	0.033	*Ti* 30	*Ti* 30	"	7.2	7.4			4; 4	A	
ε *Can. Maj.*	B461	Nov. 19	20 59	37	W 0 02	0.045	*Ti* 25	*Ti* 25	"	9.8	9.4	9.7	10.1	3; 1	A	Dew on object glass

DETAILED MEASURES AND REDUCTIONS

CONTROL PLATES OF THE MOON, VENUS, AND SOLAR STARS

The following section contains the results of measures upon plates of the Moon, Venus, and certain stars with known velocities taken for the purpose of guarding against instrumental errors. The series covers practically the entire interval within which the measures given in the present paper occur, and no evidence is shown of the existence of errors of this nature. The measured velocity in the case of the Moon and Venus is compared with the computed velocity, and in the case of stars with the results of other observers for the same stars. Professor Campbell's convenient formulæ were used in the derivation of the theoretical velocity of the Moon and Venus.

The detailed measurements on the different plates follow. The plates of the Moon and Venus are grouped together and arranged in chronological order, while the separate stars are given in order of right ascension. The Greenwich mean time and hour angle given for each plate refer to the middle of the exposure. Following this is the name of the person who measured the plate, the magnifying power employed, and a brief statement as to the quality of the plate. Unless otherwise specified the comparator used by Frost was G 1, by Adams G 2.

The first column of the tables contains the means of the settings upon the individual lines. S denotes a line in the spectrum of the star, Moon, or planet, while a comparison line is indicated by the symbol of the element to which it is due.

In all cases where the curvature correction is given as a fraction of a millimeter at the foot of the tables, the readings upon the comparison lines given in the first column include this correction. In a few cases the correction for curvature is applied in kilometers to the end result.

The symbols V_a and V_d are employed in the reduction of a star's velocity to the Sun, V_a denoting the correction due to the velocity of the Earth in its orbit, and V_d the correction due to the Earth's diurnal rotation. The total reduction to the Sun is, therefore, $V_a + V_d$. The corrections for the orbital velocity of the Earth have been made with the use of Schlesinger's tables of star constants (*Astrophysical Journal*, Vol. X (1899), pp. 1–13), and the diurnal corrections are taken from a table constructed for the latitude of the Yerkes Observatory.

MOON—A 246

1901, September 26, G. M. T. $14^h\,48^m$ — Measured by F.
Hour angle E $1^h\,56^m$ — Poor plate — Power 17

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Moon Lines	Wave-Length in Sun	Displacement	Velocity
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.
Ti 32.0910	Standard	±0.000	.....	4427.266		
S 32.1013	4427.392	.....	±0.000	4427.420	−0.028	−1.9
Ti 32.6522	4434.150	+0.018	.....	4434.168		
S 32.7836	4435.772	.....	+0.029	4435.851	−0.059	−4.0
Ti 33.1646	4440.495	+0.020	.....	4440.515		
S 33.3212	4442.447	.....	+0.015	4442.510	−0.048	−3.2
S 33.4414	4443.949	.....	+0.011	4443.976	−0.016	−1.1
S 33.7551	4447.883	.....	+0.002	4447.892	−0.007	−0.5
Ti 33.8689	4449.315	−0.002	.....	4449.313		
Ti 34.3556	4455.476	+0.009	.....	4455.485		
S 34.4012	4456.056	.....	+0.010	4456.030	+0.036	+2.4
Ti 34.5215	4457.588	+0.012	.....	4457.600		
S 34.5254	4457.638	.....	+0.012	4457.656	−0.006	−0.4
S 35.9614	4476.193	.....	−0.023	4476.214	−0.044	−3.0
Ti 35.9625	4476.208	−0.023	.....	4476.185		
Ti 36.3605	Standard	±0.000	.....	4481.438		
S 36.4315	4482.375	.....	−0.001	4482.376	−0.002	−0.1
S 37.3578	4494.715	.....	−0.013	4494.738	−0.036	−2.4
Fe 37.3606	4494.751	−0.013	.....	4494.738		
Ti 37.4770	4496.318	±0.000	.....	4496.318		
Ti 38.6954	4512.915	−0.009	.....	4512.906		

MOON A—246—*Continued*

Mean of Velocity	Wave-Length by Formula	Correction to Comp. Lines	Correction to Moon Lines	Wave-Length in Sun	Displacement	Velocity
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.
Ti 39.4200	4522.968	+0.006	.....	4522.974		
S 39.5838	4525.257	.....	+0.014	4525.285	−0.014	−0.9
Fe 39.8337	4528.771	+0.027	.....	4528.798		
S 39.8362	4528.806	.....	+0.027	4528.798	+0.035	+2.3
S 41.6063	4554.157	.....	±0.000	4554.211	−0.054	−3.6
Ti 41.7092	Standard	±0.000	.....	4555.662		

Curvature Cor. +0.0002 mm. Mean − 1.2 km.
Computed Velocity − 0.5

MOON—A 253

1901, September 27, G. M. T. $16^h\ 22^m$ Measured by A.
Hour angle E $1^h\ 15^m$ Moon fair; comparison fair. Power 28

Ti 26.2727	Standard	±0.000	.....	4399.935		
S 26.9485	4407.871	.....	−0.002	4407.851	+0.018	+1.2
S 27.0037	4408.524	.....	−0.002	4408.549	−0.027	−1.8
Fe 27.5735	4415.297	−0.004	.....	4415.293		
S 28.4306	4425.615	.....	−0.004	4425.608	+0.003	+0.2
Ti 28.5669	4427.270	−0.004	.....	4427.266		
S 28.5774	4427.398	.....	−0.004	4427.420	−0.026	−1.8
S 29.2661	4435.827	.....	−0.002	4435.851	−0.026	−1.8
S 29.8072	4442.524	.....	±0.000	4442.510	+0.014	+0.9
Ti 29.9238	4443.976	±0.000	.....	4443.976		
S 30.2354	4447.871	.....	±0.000	4447.892	−0.021	−1.4
Ti 30.3503	Standard	±0.000	.....	4449.313		
Ti 30.8405	4455.498	−0.013	.....	4455.485		
S 30.8828	4456.038	.....	−0.013	4456.030	−0.005	−0.3
Ti 31.6612	4465.980	−0.005	.....	4465.975		
S 32.4522	4476.234	.....	−0.004	4476.214	+0.016	+1.1
Ti 32.8494	4481.441	−0.003	.....	4481.438		
S 32.9185	4482.351	.....	−0.003	4482.376	−0.018	−1.2
S 33.8508	4494.741	.....	±0.000	4494.738	+0.003	+0.2
Ti 33.9683	Standard	±0.000	.....	4496.318		
S 34.0221	4497.041	.....	−0.001	4497.046	−0.006	−0.4
S 34.3461	4501.413	.....	−0.006	4501.422	−0.015	−1.0
Ti 34.3489	4501.451	−0.006	.....	4501.445		

Curvature Cor. +0.0001 mm. Mean −0.5 km.
Computed Velocity −0.6

VENUS—B 224

1901, November 13, G. M. T. $11^h\ 34^m$ Measured by A.
Hour angle W $2^h\ 36^m$ Planet strong; comparison good. Power 21

S 22.8566	4443.810	.....	+0.018	4443.976	−0.148	−10.0
Ti 22.8725	4443.958	+0.018	.....	4443.976		
S 23.2737	4447.696	.....	+0.005	4447.892	−0.191	12.9
Ti 23.4465	Standard	±0.000	.....	4449.313		
S 24.3103	4457.450	.....	±0.000	4457.656	−0.206	13.9
Ti 24.3261	4457.600	±0.000	.....	4457.600		
S 25.2597	4466.505	.....	−0.005	4466.701	−0.201	13.5
S 25.4657	4468.486	.....	−0.006	4468.663	−0.183	12.3
Ti 25.4848	4468.669	−0.006	.....	4468.663		
S 25.9135	4472.810	.....	−0.006	4472.958	−0.154	10.3
S 26.2453	4476.031	.....	−0.006	4476.214	−0.189	12.7
Ti 26.7995	4481.444	−0.006	.....	4481.438		
S 26.8762	4482.196	.....	−0.005	4482.376	−0.185	12.4
S 28.1202	4494.513	.....	+0.008	4494.738	−0.217	14.5

VENUS B—224—*Continued*

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Planet Lines	Wave-Length in Sun	Displacement	Velocity
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.
S 28.7897	4501.230	.....	+0.015	4501.422	−0.177	−11.8
Ti 28.8095	4501.430	+0.015	.....	4501.445		
Ti 29.9391	4512.911	−0.005	.....	4512.906		
S 30.1705	4515.285	.....	−0.007	4515.475	−0.197	13.1
Ti 30.4542	4518.207	−0.009	.....	4518.198		
S 30.8831	4522.647	.....	+0.008	4522.853	−0.198	13.1
Ti 30.9138	4522.966	+0.008	.....	4522.974		
Ti 31.3480	Standard	±0.000	.....	4527.490		
S 31.4548	4528.607	.....	±0.000	4528.798	−0.191	12.6
S 32.9699	4544.641	.....	+0.009	4544.845	−0.195	12.9
Ti 32.9899	4544.855	+0.009	.....	4544.864		
Ti 33.7114	4552.616	+0.016	.....	4552.632		
S 33.8378	4553.984	.....	+0.009	4554.211	−0.218	14.4
Ti 33.9925	4555.662	±0.000	.....	4555.662		
S 34.7268	4563.678	.....	+0.040	4563.939	−0.221	14.5
Ti 34.7469	4563.899	+0.040	.....	4563.939		
Ti 35.4926	4572.130	+0.026	.....	4572.156		
S 36.3248	4581.424	.....	+0.017	4581.634	−0.193	12.6
S 37.0751	4589.901	.....	+0.009	4590.126	−0.216	14.1
Ti 37.0941	4590.117	+0.009	.....	4590.126		
S 38.9256	4611.221	.....	+0.002	4611.455	−0.232	15.1
Ti 39.4569	Standard	±0.000	.....	4617.452		

Curvature Cor. +0.0009 mm. Mean −13.0 km.
Computed Velocity −12.8

MOON—B 254

1901, December 18, G. M. T. 13h 36m Measured by A.
Hour angle W 1h 32m Moon good; comparison rather strong. Power 21

S 23.4084	4442.519	.....	+0.028	4442.510	+0.037	+2.5
Ti 23.5599	4443.948	+0.028	.....	4443.976		
S 23.5648	4443.994	.....	+0.028	4443.976	+0.046	+3.1
S 23.9804	4447.929	.....	+0.007	4447.892	+0.044	+3.0
Ti 24.1260	Standard	±0.000	.....	4449.313		
S 25.9346	4466.735	.....	+0.008	4466.701	+0.042	+2.8
Ti 26.1311	4468.654	+0.009	.....	4468.663		
S 26.1334	4468.676	.....	+0.009	4468.663	+0.022	+1.5
S 26.8995	4476.209	.....	−0.010	4476.214	−0.015	−1.0
Ti 27.4289	4481.461	−0.023	.....	4481.438		
S 27.5242	4482.410	.....	−0.023	4482.376	+0.011	+0.7
S 28.7507	4494.745	.....	−0.029	4494.738	−0.022	−1.5
Ti 28.9085	4496.348	−0.030	.....	4496.318		
S 29.4085	4501.450	.....	−0.022	4501.422	+0.006	+0.4
S 30.0898	4508.459	.....	−0.012	4508.455	−0.008	−0.5
Ti 30.5192	4512.911	−0.005	.....	4512.906		
S 31.6950	4525.245	.....	−0.001	4525.285	−0.041	−2.7
Ti 31.9069	Standard	±0.000	.....	4527.490		
S 32.0338	4528.838	.....	+0.002	4528.798	+0.042	+2.8
Ti 34.2333	4552.595	+0.037	.....	4552.632		
S 34.3791	4554.197	.....	+0.032	4554.211	+0.018	+1.2
Ti 35.2587	4563.935	+0.004	.....	4563.939		
S 35.2583	4563.931	.....	+0.004	4563.939	−0.004	−0.3
S 35.9126	4571.256	.....	+0.012	4571.275	−0.007	−0.5
S 36.8271	4581.615	.....	+0.026	4581.634	+0.007	+0.5
S 37.0370	4584.013	.....	+0.027	4584.018	+0.022	+1.4
Ti 37.5662	4590.092	+0.034	.....	4590.126		
S 39.3891	4611.405	.....	+0.008	4611.455	−0.042	−2.7
S 39.5611	4613.447	.....	+0.005	4613.465	−0.013	−0.8
Ti 39.8972	Standard	±0.000	.....	4617.452		

Curvature Cor. +0.0007 mm. Mean +0.5 km.
Computed Velocity +0.9

VENUS—A 303

1902, January 8, G. M. T. $11^h\ 28^m$ — Measured by A.
Hour angle W $2^h\ 35^m$ — Planet strong; comparison good. — Power 28

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Planet Lines	Wave-Length in Sun	Displacement	Velocity
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.
S 19.3514	4282.435	.....	±0.000	4282.565	−0.130	−9.1
Ti 19.3948	Standard	±0.000	.....	4282.860		
S 19.4101	4283.010	.....	±0.000	4283.169	−0.159	11.1
Ti 19.7313	4286.165	+0.003	.....	4286.168		
Ti 19.8736	4287.569	−0.003	.....	4287.566		
S 20.0575	4289.387	.....	−0.003	4289.525	−0.141	9.9
S 20.4322	4293.110	.....	−0.004	4293.241	−0.135	9.4
S 20.5327	4294.113	.....	−0.004	4294.278	−0.169	11.8
S 21.3067	4301.892	.....	−0.006	4302.039	−0.153	10.7
Ti 21.3264	4302.091	−0.006	.....	4302.085		
Ti 21.7183	4306.071	+0.007	.....	4306.078		
S 21.7862	4306.763	.....	+0.006	4306.912	−0.143	10.0
Ti 22.3978	Standard	±0.000	.....	4313.034		
S 22.5919	4315.038	.....	−0.001	4315.209	−0.172	12.0
S 22.9415	4318.664	.....	−0.001	4318.817	−0.154	10.7
Ti 23.1771	4321.121	−0.002	.....	4321.119		
S 24.6832	4337.064	.....	+0.001	4337.216	−0.151	10.4
Ti 24.7781	4338.083	+0.001	.....	4338.084		
S 24.9997	4340.468	.....	+0.002	4340.634	−0.164	11.3
Ti 25.3675	4944.448	+0.003	.....	4944.451		
S 26.0460	4351.858	.....	+0.002	4352.007	−0.147	10.1
S 27.1522	4364.132	.....	±0.000	4364.274	−0.142	9.8
Ti 27.4820	Standard	±0.000	.....	4367.839		

Curvature Cor. +0.0005 mm.

Mean −10.5 km.
Computed Velocity −11.3

MOON—A 320

1902, February 19, G. M. T. $13^h\ 20^m$ — Measured by A.
Hour angle E $2^h\ 38^m$ — Moon strong; comparison good. — Power 21

S 31.3732	4399.921	.....	±0.000	4399.903	+0.018	+1.2
Ti 31.3744	Standard	±0.000	.....	4399.935		
S 32.0370	4407.849	.....	+0.003	4407.851	+0.001	+0.1
Ti 33.6288	4427.257	+0.009	.....	4427.266		
S 34.1240	4433.410	.....	+0.012	4433.390	+0.032	+2.2
Ti 34.1836	4434.155	+0.013	.....	4434.168		
S 34.3183	4435.840	.....	+0.011	4435.851	±0.000	±0.0
S 34.8483	4442.514	.....	+0.005	4442.510	+0.009	+0.6
Ti 34.9634	4443.972	+0.004	.....	4443.976		
S 34.9637	4443.975	.....	+0.004	4443.976	+0.003	+0.2
S 35.2711	4447.884	.....	+0.001	4447.892	−0.007	−0.5
Ti 35.3830	Standard	±0.000	.....	4449.313		
Ti 36.0271	4457.594	+0.006	.....	4457.600		
S 36.2492	4460.473	.....	+0.007	4460.460	+0.020	+1.3
Ti 36.8753	4468.654	+0.009	.....	4468.663		
S 36.8769	4468.675	.....	+0.009	4468.663	+0.021	+1.4
S 36.9399	4469.504	.....	+0.009	4469.511	+0.002	+0.1
S 37.4477	4476.219	.....	+0.015	4476.214	+0.020	+1.3
Ti 37.8376	4481.420	+0.018	.....	4481.438		
S 37.9107	4482.399	.....	+0.016	4482.376	+0.039	+2.6
S 38.8237	4494.747	.....	+0.002	4494.738	+0.011	+0.7
Ti 38.9387	Standard	±0.000	.....	4496.318		
S 38.9949	4497.087	.....	±0.000	4497.046	+0.041	+2.7
S 39.3121	4501.443	.....	+0.007	4501.422	+0.028	+1.9
Ti 39.3118	4501.438	+0.007	.....	4501.445		

Curvature Cor. +0.0005 mm.

Mean +1.1 km.
Computed Velocity +0.7

MOON—A 337

1902, March 26, G. M. T. $20^h\,49^m$ — Measured by A.
Hour angle W $0^h\,28^m$ — Moon fair; comparison rather strong. — Power 20

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Moon Lines	Wave-Length in Sun	Displacement	Velocity
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.
S 29.3921	4425.611	.....	±0.000	4425.608	+0.003	+0.2
Ti 29.5265	Standard	±0.000	.....	4427.266		
S 29.5386	4427.415	.....	±0.000	4427.420	−0.005	−0.3
S 30.1644	4435.174	.....	−0.002	4435.184	−0.012	−0.8
S 30.7503	4442.519	.....	−0.005	4442.510	−0.004	+0.3
Ti 30.8661	4443.981	−0.005	.....	4443.976		
S 30.8668	4443.989	.....	−0.005	4443.976	+0.008	+0.5
S 31.1765	4447.913	.....	−0.014	4447.892	+0.007	+0.5
Ti 31.2881	4449.331	−0.018	.....	4449.313		
S 32.6364	4466.708	.....	−0.017	4466.701	−0.010	−0.7
S 32.7860	4468.663	.....	−0.017	4468.663	−0.017	−1.1
Ti 32.7873	4468.680	−0.017	.....	4468.663		
S 33.3607	4476.225	.....	−0.012	4476.214	−0.001	−0.1
S 33.8257	4482.403	.....	−0.008	4482.376	+0.019	+1.3
S 34.7438	4494.760	.....	−0.001	4494.738	+0.021	+1.4
Ti 34.8584	Standard	±0.000	.....	4496.318		
S 35.2334	4501.439	.....	−0.001	4501.422	−0.016	+1.1
Ti 35.2339	4501.446	−0.001	.....	4501.445		
Ti 36.0651	4512.928	−0.022	.....	4512.906		
S 36.2473	4515.470	.....	−0.012	4515.475	−0.017	−1.1
S 36.7711	4522.826	.....	+0.018	4522.853	−0.009	−0.6
Ti 36.7803	4522.956	+0.018	.....	4522.974		
Ti 37.0998	4527.481	+0.009	.....	4527.490		
S 37.1925	4528.799	.....	+0.009	4528.798	+0.010	+0.7
Ti 38.8393	4552.617	+0.015	.....	4552.632		
Ti 39.6038	Standard	±0.000	.....	4563.939		
S 39.6048	4563.954	.....	±0.000	4563.939	+0.015	+1.0

Curvature Cor. +0.0005 mm. — Mean +0.1 km.
Computed Velocity +0.1

MOON—B 328

1902, April 19, G. M. T. $14^h\,40^m$ — Measured by A.
Hour angle E $1^h\,15^m$ — Moon good; comparison good. — Power 17

S 28.5408	4415.250	.....	±0.000	4415.244	+0.006	+0.4
Ti 28.8334	4417.884	±0.000	.....	4417.884		
Ti 29.8664	Standard	±0.000	.....	4427.266		
S 29.8839	4427.426	.....	±0.000	4427.420	+0.006	+0.4
S 30.8023	4435.879	.....	+0.007	4435.851	+0.035	+2.4
S 31.5146	4442.508	.....	+0.013	4442.510	+0.011	+0.7
Ti 31.6699	4443.962	+0.014	.....	4443.976		
S 31.6721	4443.983	.....	+0.014	4443.976	+0.021	+1.4
S 32.0910	4447.920	.....	−0.004	4447.892	+0.024	+1.6
Ti 32.2397	4449.323	−0.010	.....	4449.313		
S 32.9485	4456.049	.....	−0.002	4456.030	+0.017	+1.1
Ti 33.1109	Standard	±0.000	.....	4457.600		
S 33.1168	4457.656	.....	±0.000	4457.656	±0.000	±0.0
S 34.2596	4468.667	.....	−0.006	4468.663	−0.002	−0.1
Ti 34.2598	4468.669	−0.006	.....	4468.663		
S 35.0342	4476.230	.....	±0.000	4476.314	+0.016	+1.1
Ti 35.5624	4481.434	+0.004	.....	4481.438		
S 35.6585	4482.385	.....	+0.004	4482.376	+0.013	+0.9
S 36.8951	4494.737	.....	±0.000	4494.738	−0.001	−0.1
Ti 37.0518	Standard	±0.000	.....	4496.318		
Ti 37.5576	4501.444	+0.001	.....	4501.445		
S 37.5578	4501.446	.....	+0.001	4501.422	+0.025	+1.7

Curvature Cor. +0.0008 mm. — Mean +0.9 km.
Computed Velocity +0.9

MOON—B 363

1902, June 20, G. M. T. $18^h\,55^m$ — Measured by A.
Hour angle W $0^h\,50^m$ — Moon fair; comparison good. — Power 20

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Moon Lines	Wave-Length in Sun	Displacement	Velocity
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.
S 19.1323	4425.622	.....	±0.000	4425.608	+0.014	+1.0
Ti 19.3130	Standard	±0.000	.....	4427.266		
S 19.3330	4427.448	.....	±0.000	4427.420	+0.028	+1.9
S 20.2503	4435.860	.....	+0.017	4435.851	+0.026	+1.8
S 20.9677	4442.513	.....	+0.029	4442.510	+0.032	+2.2
S 21.1205	4443.939	.....	+0.032	4443.976	−0.005	−0.3
Ti 21.1210	4443.944	+0.032	.....	4443.976		
S 21.5405	4447.873	.....	+0.027	4447.892	+0.008	+0.5
Ti 21.6909	4449.288	+0.025	.....	4449.313		
Ti 22.3462	Standard	±0.000	.....	4455.485		
S 22.4025	4456.020	.....	+0.001	4456.030	−0.009	−0.6
S 23.7181	4468.645	.....	+0.034	4468.663	+0.016	+1.1
Ti 23.7164	4468.629	+0.034	.....	4468.663		
S 24.4939	4476.201	.....	+0.020	4476.214	+0.007	+0.5
Ti 25.0256	4481.427	+0.011	.....	4481.438		
S 25.1198	4482.358	.....	+0.011	4482.376	−0.007	−0.5
S 26.3633	4494.754	.....	+0.015	4494.738	+0.031	+2.1
Ti 26.5171	4496.302	+0.016	.....	4496.318		
S 26.5898	4497.036	.....	+0.016	4497.052	+0.006	+0.4
S 27.0243	4501.434	.....	±0.000	4501.422	+0.012	+0.8
Ti 27.0254	Standard	±0.000	.....	4501.445		

Curvature Cor. +0.0008 mm. — Mean +0.8 km.
Computed Velocity +0.2

MOON—B 363

Measured by F.
Power 23

Ti 30.6616	Standard	±0.000	.....	4427.266		
S 30.6809	4427.442	.....	±0.000	4427.420	+0.022	+1.5
Ti 31.4173	4434.189	−0.021	.....	4434.168		
S 31.5268	4435.199	.....	−0.021	4435.184	−0.006	−0.4
S 32.3159	4442.536	.....	−0.004	4442.510	+0.022	+1.5
Ti 32.4724	4443.977	−0.001	.....	4443.976		
S 32.4726	4443.978	.....	−0.001	4443.976	+0.001	+0.1
S 32.8904	4447.893	.....	−0.009	4447.892	−0.008	−0.5
Ti 33.0428	4449.327	−0.014	.....	4449.313		
S 33.3024	4451.776	.....	−0.016	4451.752	+0.008	+0.5
Ti 33.6958	4455.503	−0.018	.....	4455.485		
S 33.7513	4456.031	.....	−0.018	4456.030	−0.017	−1.1
Ti 34.7906	4465.985	−0.010	.....	4465.975		
S 35.0678	4468.664	.....	−0.014	4468.663	−0.013	−0.9
Ti 35.3524	4471.426	−0.018	.....	4471.408		
S 35.8438	4476.220	.....	−0.009	4476.214	−0.003	−0.2
Ti 36.3748	Standard	±0.000	.....	4481.438		
S 36.4713	4482.390	.....	±0.000	4482.375	+0.015	+1.0
S 37.7111	4494.742	.....	−0.003	4494.738	+0.001	+0.1
Ti 37.8680	4496.321	−0.003	.....	4496.318		
S 37.9397	4497.044	.....	−0.003	4497.046	−0.005	−0.3
S 38.3715	4501.412	.....	+0.010	4501.448	−0.026	−1.7
Ti 38.3741	4501.438	+0.010	.....	4501.448		
S 39.0627	4508.459	.....	−0.002	4508.455	+0.002	+0.1
Ti 39.4964	4512.917	−0.011	.....	4512.906		
S 40.2157	4520.372	.....	−0.002	4520.397	−0.027	−1.8
Ti 40.4650	Standard	±0.000	.....	4522.974		
S 40.4530	4522.849	.....	±0.000	4522.871	−0.022	−1.5
Ti 40.8955	4527.489	+0.001	.....	4527.490		
S 41.0209	4528.810	.....	+0.001	4528.798	+0.013	+0.9

Curvature Cor. + 0.0013 mm. — Mean −0.2 km.
Computed Velocity +0.2

MOON—A 350

1902, July 16, G. M. T. $14^h\ 28^m$ — Measured by A.
Hour angle E $0^h\ 42^m$ — Moon fair; comparison fair. — Power 17

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Moon Lines	Wave-Length in Sun	Displacement	Velocity
mm.	t. m.	t. m	t. m.	t. m.	t. m.	km.
Ti 30.3399	Standard	±0.000	.....	4427.266		
S 30.3552	4427.454	.....	±0.000	4427.420	+0.034	+2.3
S 30.9607	4435.178	.....	+0.006	4435.184	±0.000	±0.0
S 31.5670	4442.498	.....	+0.012	4442.510	±0.000	±0.0
Ti 31.6836	4443.963	+0.013	.....	4443.976		
S 31.9948	4447.891	.....	−0.004	4447.892	−0.005	−0.3
Ti 32.1081	4449.323	−0.010	.....	4449.313		
Ti 32.5937	4455.506	−0.021	.....	4455.485		
S 32.6366	4456.055	.....	−0.021	4456.030	+0.004	+0.3
Ti 33.6143	4468.682	−0.019	.....	4468.663		
S 34.1884	4476.204	.....	−0.008	4476.214	−0.018	−1.2
Ti 34.5843	Standard	±0.000	.....	4481.438		
S 34.6546	4482.372	.....	−0.001	4482.376	−0.005	−0.3
S 35.5784	4494.753	.....	−0.010	4494.738	+0.005	+0.3
Ti 35.6948	4496.329	−0.011	.....	4496.318		
S 35.7484	4497.055	.....	−0.011	4497.046	−0.002	−0.1
S 36.0693	4501.421	.....	−0.013	4501.422	−0.014	−0.9
Ti 36.0720	4501.458	−0.013	.....	4501.445		
S 37.0281	4514.625	.....	−0.008	4514.617	+0.002	+0.1
Ti 37.9457	Standard	±0.000	.....	4527.490		
S 38.0405	4528.832	.....	−0.001	4528.798	+0.033	+2.2
S 38.4194	4534.221	.....	−0.010	4534.168	+0.043	+2.8
Ti 38.4714	4534.964	−0.011	.....	4534.953		

Curvature Cor. +0.0005 mm.

Mean +0.4 km.
Computed Velocity +0.4

MOON—B 401

1902, August 27, G. M. T. $21^h\ 47^m$ — Measured by A.
Hour angle E $3^h\ 44^m$ — Moon slightly weak; comparison fair. — Power 28

S 29.0862	4425.591	.....	±0.000	4425.608	−0.017	−1.2
Ti 29.2702	Standard	±0.000	.....	4427.266		
S 29.2843	4427.395	.....	±0.000	4427.420	−0.025	−1.7
S 30.9248	4442.512	.....	+0.003	4442.510	+0.005	+0.3
S 31.0788	4443.948	.....	+0.003	4443.976	−0.025	−1.7
Ti 31.0814	4443.973	+0.003	.....	4443.976		
S 31.4988	4447.881	.....	+0.001	4447.892	−0.010	−0.7
Ti 31.6510	4449.312	+0.001	.....	4449.313		
Ti 32.3053	4455.495	−0.010	.....	4455.485		
S 32.3612	4456.026	.....	−0.010	4456.030	−0.014	−0.9
S 33.6784	4468.651	.....	−0.018	4468.663	−0.030	−2.0
Ti 33.6815	4468.681	−0.018	.....	4468.663		
S 34.4556	4476.208	.....	−0.008	4476.214	−0.014	−0.9
Ti 34.9886	Standard	±0.000	.....	4481.438		
S 35.0827	4482.385	.....	±0.000	4482.376	−0.011	−0.7
S 36.3243	4494.714	.....	−0.003	4494.738	−0.027	−1.8
S 36.9885	4501.408	.....	−0.005	4501.422	−0.019	−1.3
Ti 36.9927	4501.450	−0.005	.....	4501.445		
S 39.0727	4522.824	.....	+0.003	4522.853	−0.026	−1.7
Ti 39.0868	4522.971	+0.003	.....	4522.974		
S 39.3065	4525.266	.....	+0.001	4525.285	−0.018	−1.2
Ti 39.5187	Standard	±0.000	.....	4527.490		
S 39.6431	4528.797	.....	±0.000	4528.798	−0.001	−0.1

Curvature Cor. +0.0008 mm.

Mean −1.1 km.
Computed Velocity −1.5

MOON — B 408

1902, September 13, G. M. T. $16^h\,13^m$
Hour angle W $1^h\,14^m$

Moon good; comparison good.

Measured by A.
Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Moon Lines	Wave-Length in Sun	Displacement	Velocity
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.
Ti 31.7436	Standard	±0.000	.....	4427.266		
S 31.7599	4427.415	.....	±0.000	4427.420	−0.005	−0.3
S 32.4112	4433.390	.....	+0.005	4433.390	+0.005	+0.3
S 33.3929	4442.495	.....	+0.011	4442.510	−0.004	−0.3
S 33.5520	4443.982	.....	+0.012	4443.976	+0.018	+1.2
Ti 33.5501	4443.964	+0.012	.....	4443.976		
S 33.9700	4447.904	.....	+0.005	4447.892	+0.017	+1.2
Ti 34.1194	4449.311	+0.002	.....	4449.313		
Ti 34.7714	4455.486	−0.001	.....	4455.485		
S 34.8303	4456.046	.....	−0.001	4456.030	+0.015	+1.0
Ti 34.9933	Standard	±0.000	.....	4457.600		
S 34.9984	4457.648	.....	±0.000	4457.656	−0.008	−0.5
Ti 36.1445	4468.671	−0.008	.....	4468.663		
S 36.1456	4468.682	.....	−0.008	4468.663	+0.011	+0.7
S 36.9185	4476.214	.....	−0.006	4476.214	−0.006	−0.4
Ti 37.4503	4481.443	−0.005	.....	4481.438		
S 37.5453	4482.381	.....	−0.005	4482.376	±0.000	±0.0
S 38.7829	4494.718	.....	±0.000	4494.738	−0.020	−1.3
Ti 38.9418	Standard	±0.000	.....	4496.318		
S 39.0126	4497.032	.....	±0.000	4497.046	−0.14	−0.9

Curvature Cor. + 0.0009 m.

Mean + 0.1 km.
Computed Velocity + 0.2

MOON — B 423

1902, October 15, G. M. T. $15^h\,44^m$
Hour angle E $1^h\,1^m$

Moon good; comparison good.

Measured by A.
Power 21

Ti 33.6163	Standard	±0.000	.....	4427.266		
S 33.6324	4427.413	.....	±0.000	4427.420	−0.007	−0.5
S 35.2019	4441.876	.....	+0.006	4441.881	+0.001	+0.1
S 35.2673	4442.485	.....	+0.006	4442.510	−0.019	−1.3
S 35.4234	4443.942	.....	+0.007	4443.976	−0.025	−1.7
Ti 35.4282	4443.969	+0.007	.....	4443.976		
S 35.8448	4447.891	.....	+0.005	4447.892	+0.004	+0.3
Ti 35.9956	4449.309	+0.004	.....	4449.313		
Ti 36.6475	4455.475	+0.010	.....	4455.485		
S 36.7044	4456.016	.....	+0.007	4456.030	−0.007	−0.5
Ti 36.8708	Standard	±0.000	.....	4457.600		
S 36.8771	4457.660	.....	±0.000	4457.656	+0.004	+0.3
S 38.0184	4468.625	.....	+0.006	4468.663	−0.032	−2.1
Ti 38.0218	4468.657	+0.006	.....	4468.663		
S 38.7970	4476.206	.....	+0.011	4476.214	+0.003	+0.2
Ti 39.3279	4481.423	+0.015	.....	4481.438		
S 39.4226	4482.357	.....	+0.015	4482.376	−0.004	−0.3
S 40.6621	4494.707	.....	+0.017	4494.738	−0.014	−0.9
Ti 40.8205	4496.301	+0.017	.....	4496.318		
S 40.8926	4497.028	.....	+0.015	4497.046	−0.003	−0.2
S 41.3250	4501.401	.....	±0.000	4501.422	−0.021	−1.4
Ti 41.3293	Standard	±0.000		4501.445		

Curvature Cor. + 0.0008 mm.

Mean − 0.6 km.
Computed Velocity − 0.4

MOON—B 444

1902, November 6, G. M. T. 13h 38m — Measured by A.
Hour angle W 2h 54m — Moon good; comparison good. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Moon Lines	Wave-Length in Sun	Displacement	Velocity
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.
Ti 34.0166	Standard	±0.000	.....	4427.266		
S 34.0332	4427.418	.....	±0.000	4427.420	−0.002	−0.1
S 34.6862	4433.410	.....	−0.014	4433.390	+0.006	+0.4
Ti 34.7701	4434.184	−0.016	.....	4434.168		
S 34.9510	4435.856	.....	−0.010	4435.851	−0.005	−0.3
S 35.6659	4442.504	.....	+0.012	4442.510	+0.006	+0.4
Ti 35.8214	4443.959	+0.017	.....	4443.976		
S 35.8245	4443.988	.....	+0.017	4443.976	+0.029	+2.0
S 36.2407	4447.897	.....	+0.005	4447.892	+0.010	+0.6
Ti 36.3907	4449.312	+0.001	.....	4449.313		
Ti 37.0401	4455.471	+0.014	.....	4455.485		
S 37.1005	4456.047	.....	+0.010	4456.030	+0.027	+1.8
Ti 37.2632	Standard	±0.000	.....	4457.600		
S 37.2718	4457.682	.....	±0.000	4457.656	+0.026	+1.7
S 38.4118	4468.668	.....	−0.009	4468.663	−0.004	−0.3
Ti 38.4123	4468.672	−0.009	.....	4468.663		
S 39.1858	4476.228	.....	+0.008	4476.214	+0.022	+1.5
Ti 39.7123	4481.419	+0.019	.....	4481.438		
S 39.8069	4482.356	.....	+0.018	4482.376	−0.002	−0.1
S 41.0457	4494.743	.....	+0.002	4494.738	+0.007	+0.5
Ti 41.2016	Standard	±0.000	.....	4496.318		
S 41.2751	4497.061	.....	±0.000	4497.046	+0.015	+1.0
S 41.7048	4501.425	.....	+0.001	4501.422	+0.004	+0.3
Ti 41.7067	4501.444	+0.001	.....	4501.445		

Curvature Cor. +0.0009 mm. — Mean +0.7 km.
Computed Velocity +0.6

α ARIETIS

The plate of *α Arietis* given below was previously published in Frost's paper on the Bruce spectrograph [15] as an example of the method of reduction.

α ARIETIS—B 233

1901, November 15, G. M. T. 14h 36m — Measured by A.
Hour angle E 1h 40m — Star good; comparison strong. — Power 21

S 28.0279	4442.418	.....	+0.015	4442.510	−0.077	−5.2
S 28.1850	4443.880	.....	+0.015	4443.976	−0.081	5.5
Ti 28.1937	4443.961	+0.015	.....	4443.976		
S 28.6055	4447.808	.....	+0.004	4447.892	−0.080	5.4
Ti 28.7659	Standard	±0.000	.....	4449.313		
S 29.0187	4451.691	.....	−0.001	4451.752	−0.062	4.2
Ti 29.6436	4457.604	−0.004	.....	4457.600		
S 30.7931	4468.614	.....	−0.004	4468.663	−0.053	3.6
Ti 30.7987	4468.667	−0.004	.....	4468.663		
S 31.5695	4476.148	.....	+0.003	4476.214	−0.063	4.2
Ti 32.1089	4481.431	+0.007	.....	4481.438		
S 32.1972	4482.300	.....	+0.006	4482.376	−0.070	4.7
Ti 32.8241	4488.497	−0.004	.....	4488.493		
S 33.4467	4494.705	.....	−0.016	4494.738	−0.049	3.3
Ti 33.6095	4496.337	−0.019	.....	4496.318		
S 34.1050	4501.329	.....	−0.003	4501.422	−0.096	6.4
Ti 34.1168	4501.448	−0.003	.....	4501.445		
S 35.2379	4512.873	.....	−0.014	4512.906	−0.047	3.1
Ti 35.2425	4512.920	−0.014	.....	4512.906		
S 35.4846	4515.411	.....	−0.012	4515.475	−0.076	5.1
Ti 36.6468	Standard	±0.000	.....	4527.490		
S 36.7676	4528.757	.....	−0.006	4528.798	−0.047	3.1
S 37.3481	4534.877	.....	−0.033	4534.953	−0.109	7.2
Ti 37.3585	4534.986	−0.033	.....	4534.953		
Ti 38.2862	4544.874	−0.010	.....	4544.864		
S 38.3976	4546.071	.....	−0.009	4546.129	−0.067	4.4

[15] *Astrophysical Journal*, Vol. XV (1902), pp. 1-27.

α ARIETIS—B 233—*Continued*

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Wave-Length in Sun	Displacement	Velocity
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.
Ti 39.0060	4552.639	−0.007	.....	4552.632		
S 39.1432	4554.128	.....	−0.013	4554.211	−0.096	6.3
Ti 39.2861	4555.682	−0.020	.....	4555.662		
S 40.0346	4563.876	.....	−0.006	4563.939	−0.069	4.5
Ti 40.0409	4563.945	−0.006	.....	4563.939		
S 40.6947	4571.177	.....	−0.002	4571.275	−0.100	6.6
S 40.7752	4572.072	.....	−0.002	4572.156	−0.086	5.6
Ti 40.7829	4572.158	−0.002	.....	4572.156		
S 41.2421	4577.286	.....	−0.007	4577.356	−0.077	5.0
S 42.3755	4590.083	.....	−0.020	4590.126	−0.053	3.5
Ti 42.3801	4590.146	−0.020	.....	4590.126.		
S 44.6303	4616.228	.....	−0.001	4616.305	−0.078	5.1
S 44.7282	4617.383	.....	±0.000	4617.452	−0.069	4.5
Ti 44.7340	Standard	±0.000	.....	4617.452		

Curvature Cor. +0.0008 mm.

Mean − 4.8
V_a −8.91
V_d +0.13
Reduction to Sun − 8.78
Radial Velocity −13.6 km.

The results of other observers for this star are as follows:

Vogel	−14.5
Scheiner	−14.9
Lord	−14.0
Campbell	−14.1

α *TAURI*

Two plates of this star have been measured, both by A. Of these B 191 is slightly inferior for measurement on account of the narrowness of its star spectrum, the photograph having been taken previous to the change of windows in the occulting bar.

α TAURI—B 191

1901, September 4, G. M. T. $20^h\ 0^m$
Hour angle E $3^h\ 27^m$

Star good; comparison fair.

Measured by A. with Zeiss Comparator Power 20

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Wave-Length in Sun	Displacement	Velocity
mm	t. m.	t. m.	t. m.	t. m.	t. m.	km
Ti 46.0655	Standard	±0.000	.....	4457.600		
S 46.0170	4458.060	.....	±0.000	4457.656	+0.404	+27.2
Ti 44.9084	4468.656	+0.007	.....	4468.663		
S 44.0847	4476.633	.....	−0.025	4476.214	+0.394	26.4
Ti 43.5887	4481.480	−0.042	.....	4481.438		
Ti 41.5760	4501.488	−0.043	.....	4501.445		
S 41.5383	4501.868	.....	−0.043	4501.422	+0.403	26.8
S 40.4909	4512.508	.....	−0.074	4512.063	+0.371	24.7
Ti 40.4446	4512.982	−0.076	.....	4512.906		
S 40.4064	4513.373	.....	−0.076	4512.906	+0.391	26.0
Ti 39.9322	4518.248	−0.050	.....	4518.198		
S 39.8965	4518.616	.....	−0.050	4518.198	+0.368	24.4
Ti 39.4690	4523.041	−0.067	.....	4522.974		
S 39.0793	4527.097	.....	−0.069	4526.644	+0.384	25.4
Ti 39.0350	4527.559	−0.069	.....	4527.490		
S 38.9948	4527.979	.....	−0.069	4527.518	+0.392	26.0
S 38.8704	4529.280	.....	−0.064	4528.798	+0.418	27.7
S 38.4366	4533.831	.....	−0.051	4533.419	+0.367	24.3
Ti 38.3261	4535.000	−0.047	.....	4534.953		
Ti 37.3919	4544.921	−0.057	.....	4544.864		
S 37.3562	4545.303	.....	−0.057	4544.864	+0.382	25.2
S 37.2345	4546.606	.....	−0.065	4546.129	+0.412	27.2
Ti 37.0099	4549.016	−0.078	.....	4548.938		
S 36.9726	4549.417	.....	−0.078	4548.938	+0.401	26.4

α *TAURI*—B 191—*Continued*

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Wave-Length in Sun	Displacement	Velocity
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.
S 36.8960	4550.241	.....	−0.089	4549.767	+0.405	26.7
S 36.4873	4554.654	.....	−0.055	4554.211	+0.388	25.6
Ti 36.3896	4555.713	−0.051	.....	4555.662		
S 36.3502	4556.140	.....	−0.051	4555.662	+0.427	28.1
Ti 35.6352	Standard	±0.000	.....	4563.939		
S 35.4341	4566.147	.....	+0.002	4565.750	+0.399	26.2
S 34.9308	4571.700	.....	+0.006	4571.275	+0.431	28.3
Ti 34.8903	4572.150	+0.006	.....	4572.156		
S 34.8516	4572.579	.....	+0.006	4572.156	+0.429	28.1
S 32.1946	4602.620	.....	−0.007	4602.183	+0.430	28.0
S 30.9806	4616.743	.....	−0.014	4616.305	+0.424	27.5
Ti 30·9191	4617.466	−0.014	.....	4617.452		
S 30.8819	4617.903	.....	−0.014	4617.452	+0.437	28.4
Ti 30.4227	4623.321	−0.042	.....	4623.279		
S 29.5666	4633.520	.....	−0.035	4633.078	+0.407	26.3
S 28.0527	4651.883	.....	−0.021	4651.461	+0.401	25.8
S 27.9800	4652.777	.....	−0.020	4652.343	+0.414	26.7
Ti 27.6645	4656.662	−0.018	.....	4656.644		
S 27.6303	4657.083	.....	−0.018	4656.644	+0.421	27.1
S 27.0799	4663.910	.....	−0.005	4663.481	+0.424	27.3
Ti 26.7709	Standard	±0.000	.....	4667.768		

Curvature Cor. +0.0002 mm.

Mean +26.6
V_a +29.29
V_d + 0.26
Reduction to Sun +29.55
Radial Velocity +56.1 km.

α *TAURI*—B 275

1902, January 16, G. M. T. 16h 15m
Hour angle E 0h 33m

Star good; comparison good.

Measured by A.
Power 20

Ti 29.0002	Standard	±0.000	.....	4417.884		
S 29.3656	4421.203	.....	+0.015	4420.100	+1.118	+75.9
Ti 30.0248	4427.231	+0.035	.....	4427.266		
S 31.0761	4436.956	.....	+0.020	4435.851	+1.125	76.1
S 31.7232	4443.012	.....	+0.009	4441.881	+1.140	77.0
S 31.7933	4443.671	.....	+0.008	4442.510	+1.169	78.9
Ti 31.8249	4443.968	+0.008	.....	4443.976		
Ti 31.9487	4445.134	.....	+0.008	4443.976	+1.166	78.7
S 32.3640	4449.061	.....	+0.009	4447.892	+1.178	79.4
Ti 32.3897	4449.304	+0.009	.....	4449.313		
Ti 33.2583	4457.591	+0.009	.....	4457.600		
S 33.6781	4461.632	.....	−0.015	4460.460	+1.157	77.8
S 33.8214	4463.017	.....	−0.024	4461.818	+1.175	79.0
Ti 33.9900	4464.650	−0.033	.....	4464.617		
S 34.3228	4467.883	.....	−0.009	4466.701	+1.173	78.7
Ti 34.4032	4468.667	−0.004	.....	4468.663		
S 35.2905	4477.372	.....	−0.001	4476.214	+1.157	77.5
Ti 35.7012	Standard	±0.000	.....	4481.438		
S 35.9172	4483.586	.....	−0.007	4482.376	+1.203	80.5
Ti 36.4875	4489.288	−0.026	.....	4489.262		
S 36.6679	4491.101	.....	−0.030	4489.911	+1.160	77.5
Ti 37.6928	4501.490	−0.045	.....	4501.445		
S 37.8038	4502.624	.....	−0.045	4501.422	+1.157	77.1
S 38.1535	4506.209	.....	−0.030	4505.003	+1.176	78.3
Ti 38.8029	4512.914	−0.008	.....	4512.906		
S 38.9166	4514.094	.....	−0.008	4512.906	+1.180	78.4
Ti 40.1942	Standard	±0.000	.....	4527.490		
S 40.2266	4527.833	.....	±0.000	4526.644	+1.189	78.8
S 40.4312	4530.002	.....	±0.000	4528.798	+1.204	79.7

Curvature Cor. +0.0008 mm.

Mean +78.1
V_a −22.16
V_d + 0.04
Reduction to Sun −22.12
Radial Velocity +56.0 km.

SUMMARY OF MEASURES OF *α TAURI*

Plate	Date	Adams	No. of Lines
B 191	1901, Sept. 4	+56.1	27
B 275	1902, Jan. 16	+56.0	16
	Mean	+56.1 km.	

The results of other observers for this star are as follows:

Vogel	+47.6
Scheiner	+49.4
Keeler (visual)	+55.2
Campbell	+54.8

α BOÖTIS

Eight plates of this star have been measured, six by A. and four by F., giving results in good agreement. The plates are nearly all of excellent quality, with those of Series B somewhat superior for purposes of measurement.

α BOÖTIS—B 293

1902, March 12, G. M. T. $18^h\ 13^m$ — Star good; comparison good. — Measured by A.
Hour angle E $2^h\ 28^m$ — Power 20

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Wave-Length in Sun	Displacement	Velocity
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.
Ti 29.4878	Standard	±0.000	.....	4427.266		
S 29.6177	4428.456	.....	+0.001	4428.711	−0.254	−17.2
S 30.3878	4435.554	.....	+0.008	4435.851	−0.289	19.5
S 31.0376	4441.602	.....	+0.015	4441.881	−0.264	17.8
S 31.1051	4442.234	.....	+0.015	4442.510	−0.261	17.6
S 31.2619	4443.702	.....	+0.017	4443.976	−0.257	17.3
Ti 31.2893	4443.959	+0.017	.....	4443.976		
S 31.6819	4447.652	.....	−0.001	4447.892	−0.241	16.2
Ti 31.8588	4449.323	−0.010	.....	4449.313		
S 32.0882	4451.495	.....	−0.006	4451.752	−0.263	17.7
Ti 32.7282	4457.592	+0.008	.....	4457.600		
S 32.9457	4459.676	.....	+0.006	4459.922	−0.240	16.1
S 33.6462	4466.432	.....	+0.001	4466.701	−0.268	18.0
S 33.8510	4468.420	.....	±0.000	4468.663	−0.243	16.3
Ti 33.8760	Standard	±0.000	.....	4468.663		
S 34.6232	4475.966	.....	−0.004	4476.214	−0.252	16.9
Ti 35.1786	4481.444	−0.006	.....	4481.438		
S 35.2997	4482.644	.....	−0.005	4482.904	−0.265	17.7
S 36.4837	4494.487	.....	±0.000	4494.738	−0.251	16.8
S 36.7112	4496.786	.....	+0.001	4497.046	−0.259	17.3
S 37.1419	4501.158	.....	+0.003	4501.422	−0.261	17.4
Ti 37.1698	4501.442	+0.003	.....	4501.445		
S 38.2623	4512.657	.....	−0.020	4512.906	−0.269	17.9
Ti 38.2883	4512.926	−0.020	.....	4512.906		
S 38.7248	4517.458	.....	−0.011	4517.702	−0.255	16.9
S 38.7700	4517.930	.....	−0.009	4518.198	−0.277	18.4
Ti 38.7966	4518.207	−0.009	.....	4518.198		
Ti 39.2524	4522.975	−0.001	.....	4522.974		
Ti 39.6814	Standard	±0.000	.....	4527.490		
S 39.7821	4528.556	.....	−0.005	4528.798	−0.247	16.4
S 40.2876	4533.923	.....	−0.029	4534.168	−0.274	18.1
Ti 40.3106	4534.168	−0.029	.....	4534.139		
S 40.3596	4534.691	.....	−0.025	4534.953	−0.287	19.0
Ti 40.3865	4534.978	−0.025	.....	4534.953		

Curvature Cor. +0.0008 mm.

Mean −17.4
V_a +13.63
V_d + 0.19
Reduction to Sun +13.82
Radial Velocity − 3.6 km.

α *BOÖTIS*—B 300

1902, March 13, G. M. T. 17h 29m — Measured by A.
Hour angle E 3h 12m — Star good; comparison good. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Wave-Length in Sun	Displacement	Velocity
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.
Ti 30.4335	Standard	±0.000	.....	4427.266		
S 31.0758	4433.163	.....	−0.001	4433.390	−0.228	−15.4
S 31.9639	4441.589	.....	−0.002	4441.881	−0.294	19.9
S 32.0515	4442.221	.....	−0.002	4442.510	−0.291	19.6
S 32.2103	4443.706	.....	−0.002	4443.976	−0.272	18.4
Ti 32.2393	4443.978	−0.002	.....	4443.976		
S 32.6271	4447.621	.....	−0.008	4447.892	−0.279	18.8
Ti 32.8077	4449.324	−0.011	.....	4449.313		
Ti 33.6773	4457.584	+0.016	.....	4457.600		
S 33.8967	4459.684	.....	+0.013	4459.922	−0.225	15.1
S 34.0914	4461.552	.....	+0.010	4461.818	−0.256	17.2
S 34.6004	4466.461	.....	+0.003	4466.701	−0.237	15.9
S 34.8012	4468.408	.....	±0.000	4468.663	−0.255	17.1
Ti 34.8275	Standard	±0.000	.....	4468.663		
S 35.5739	4475.948	.....	−0.009	4476.214	−0.275	18.4
Ti 36.1330	4481.454	−0.016	.....	4481.438		
S 36.2010	4482.127	.....	−0.016	4482.376	−0.265	17.7
S 37.4367	4494.464	.....	−0.020	4494.738	−0.294	19.6
Ti 37.6226	4496.339	−0.021	.....	4496.318		
S 37.6675	4496.793	.....	−0.021	4497.046	−0.274	18.3
S 38.0972	4501.148	.....	−0.005	4501.422	−0.279	18.6
Ti 38.1269	4501.450	−0.005	.....	4501.445		
S 39.2206	4512.661	.....	+0.004	4512.906	−0.241	16.0
Ti 39.2440	4512.902	+0.004	.....	4512.906		
S 39.7279	4517.921	.....	−0.009	4518.198	−0.288	19.0
Ti 39.7554	4518.207	−0.009	.....	4518.198		
S 40.5344	4526.362	.....	−0.001	4526.644	−0.283	18.8
Ti 40.6414	Standard	±0.000	.....	4527.490		
S 40.7409	4528.540	.....	±0.000	4528.798	−0.258	17.1

Curvature Cor. +0.0008 mm.

Mean	−17.8
V_a	+13.26
V_d	+ 0.24
Reduction to Sun	+13.50
Radial Velocity	− 4.3 km.

α *BOÖTIS*—B 300

Measured by F.
Power 23

Ti 30.1742	Standard	±0.000	.....	4427.266		
S 30.1583	4427.120	.....	±0.000	4427.420	−0.300	−20.3
S 30.8809	4433.757	.....	+0.015	4434.021	−0.249	16.8
Ti 30.9236	4434.152	+0.016	.....	4434.168		
S 31.7920	4442.218	.....	−0.002	4442.510	−0.294	19.8
Ti 31.9804	4443.981	−0.005	.....	4443.976		
S 32.3657	4447.600	.....	−0.022	4447.892	−0.314	21.2
Ti 32.5506	4449.343	−0.030	.....	4449.313		
Ti 33.1983	4455.495	−0.010	.....	4455.485		
S 33.2254	4455.729	.....	−0.015	4456.030	−0.301	20.3
Ti 33.4195	4457.596	+0.004	.....	4457.600		
Ti 34.2930	4465.991	−0.016	.....	4465.975		
S 34.5436	4468.418	.....	−0.011	4468 663	−0.256	17.2
Ti 34.5699	4468.674	−0.011	.....	4468.663		
Ti 34.8509	4471.406	+0.002	.....	4471.408		
S 34.8675	4471.568	.....	−0.004	4471.846	−0.282	18.9
S 35.3133	4475.927	.....	−0.002	4476.214	−0.289	19.4
Ti 35.8731	Standard	±0.000	.....	4481.438		
S 35.9402	4482.101	.....	±0.000	4482.376	−0.275	18.4
S 37.1760	4494.433	.....	+0.004	4494.738	−0.301	20.1
Ti 37.3625	4496.313	+0.005	.....	4496.318		
S 37.7462	4500.196	.....	+0.007	4500.451	−0.248	16.5

α BOÖTIS—B 300—*Continued*

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Wave-Length in Sun	Displacement	Velocity
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.
S 39.4258	4517.444	.....	+0.016	4517.702	−0.242	16.1
Ti 39.4968	4518.182	+0.016	.....	4518.198		
S 40.2750	4526.323	.....	+0.014	4526.644	−0.307	20.3
S 40.3614	4527.232	.....	+0.014	4527.518	−0.272	18.0
Ti 40 3845	4527.476	+0.014	.....	4527.490		
S 40.4819	4527.503	.....	+0.014	4528.798	−0.281	18.6
Ti 42.0156	4544.866	−0.002	.....	4544.864		
S 42.1032	4545.811	.....	−0.003	4546.129	−0.314	20.7
S 42.2773	4547.695	.....	−0.006	4548.024	−0.335	22.1
S 42.3632	4548.625	.....	−0.008	4548.938	−0.321	21.2
Ti 42.3928	4548.946	−0.008	.....	4548.938		
Ti 42.7317	Standard	±0.000	.....	4552.632		
S 42.8497	4553.919	.....	+0.005	4554.211	−0.287	18.9
Ti 43.0081	4555.649	+0.013	.....	4555.662		

Curvature Cor. +0.0013 mm.

Mean −19.2
V_a +13.26
V_d + 0.24
Reduction to Sun +13.50
Radial Velocity − 5.7 km.

α BOÖTIS—A 336

1902, March 26, G. M. T. 18h 58m
Hour angle E 0h 32m

Star good; comparison strong.

Measured by A.
Power 20

Ti 29.3151	Standard	±0.000	.....	4427.266		
S 29.4149	4428.497	.....	−0.003	4428.711	−0.217	−14.7
Ti 29.8737	4434.185	−0.017	.....	4434.168		
S 30.4712	4441.664	.....	−0.011	4441.881	−0.228	15.4
S 30.5237	4442.325	.....	−0.011	4442.510	−0.196	13.2
S 30.6378	4443.764	.....	−0.009	4443.976	−0.221	14.9
Ti 30.6553	4443.985	−0.009	.....	4443.976		
S 30.9494	4447.709	.....	−0.018	4447.892	−0.201	13.6
Ti 31.0772	4449.334	−0.021	.....	4449.313		
S 31.2509	4451.548	.....	−0.017	4451.752	−0.221	14.9
Ti 31.7235	4457.609	−0.009	.....	4457.600		
S 31.9310	4460.287	.....	−0.016	4460.460	−0.189	12.7
Ti 32.3716	4466.008	−0.033	.....	4465.975		
S 32.4110	4466.522	.....	−0.033	4466.701	−0.212	14.2
S 32.5634	4468.514	.....	−0.034	4468.663	−0.183	12.3
Ti 32.5774	4468.697	−0.034	.....	4468.663		
S 33.1346	4476.028	.....	−0.013	4476.214	−0.199	13.3
Ti 33.5420	Standard	±0.000	.....	4481.438		
S 33.6004	4482.217	.....	−0.001	4482.376	−0.160	10.7
Ti 34.6475	4496.330	−0.012	.....	4496.318		
S 34.6870	4496.868	.....	−0.011	4497.046	−0.189	12.6
S 35.0058	4501.224	.....	−0.004	4501.422	−0.202	13.5
Ti 35.0222	4501.449	−0.004	.....	4501.445		
S 36.2164	4518.013	.....	−0.013	4518.198	−0.198	13.1
Ti 36.2305	4518.211	−0.013	.....	4518.198		
Ti 36.8874	Standard	±0.000	.....	4527.490		
S 36.9675	4528.629	.....	−0.006	4528.798	−0.175	11.6
S 37.3447	4534.021	.....	−0.036	4534.168	−0.183	12.1
Ti 37.3555	4534.175	−0.036	.....	4534.139		
S 37.3954	4534.748	.....	−0.023	4534.953	−0.228	15.1
Ti 37.4113	4534.976	−0.023	.....	4534.953		

Curvature Cor. +0.0005 mm.

Mean −13.4
V_a +7.97
V_d +0.04
Reduction to Sun + 8.01
Radial Velocity − 5.4 km.

α *BOÖTIS*—B 304

1902, April 2, G. M. T. $15^h\ 51^m$ — Measured by A.
Hour angle E $3^h\ 31^m$ — Star good; comparison good. — Power 20

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Wave-Length in Sun	Displacement	Velocity
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.
Ti 30.8922	Standard	±0.000	.....	4427.266		
S 31.0324	4428.551	.....	±0.000	4428.711	−0.160	−10.8
S 31.8070	4435.695	.....	−0.002	4435.851	−0.158	10.7
S 32.4550	4441.729	.....	−0.003	4441.881	−0.155	10.5
S 32.5236	4442.371	.....	−0.003	4442.510	−0.142	9.6
S 32.6807	4443.844	.....	−0.004	4443.976	−0.136	9.2
Ti 32.6952	4443.980	−0.004	.....	4443.976		
S 33.0958	4447.749	.....	−0.007	4447.892	−0.150	10.1
S 33.2499	4449.205	.....	−0.009	4449.313	−0.117	7.9
Ti 33.2623	4449.322	−0.009	.....	4449.313		
Ti 34.1327	4457.603	−0.003	.....	4457.600		
S 34.3622	4459.803	.....	−0.002	4459.922	−0.121	8.1
S 34.5565	4461.671	.....	−0.002	4461.818	−0.149	10.0
S 35.2866	4468.541	.....	±0.000	4468.663	−0.122	8.2
Ti 35.2791	Standard	±0.000	.....	4468.663		
S 36.0388	4476.090	.....	+0.004	4476.214	−0.120	8.0
Ti 36.5803	4481.432	+0.006	.....	4481.438		
S 36.6822	4482.243	.....	+0.005	4482.376	−0.128	8.6
S 37.4167	4489.763	.....	−0.003	4489.911	−0.151	10.1
S 37.8973	4494.595	.....	−0.009	4494.738	−0.152	10.1
Ti 38.0890	4496.329	−0.011	.....	4496.318		
S 38.1273	4496.919	.....	−0.009	4497.046	−0.136	9.1
S 38.5563	4501.274	.....	+0.001	4501.422	−0.147	9.8
Ti 38.5730	4501.444	+0.001	.....	4501.445		
S 39.6769	4512.776	.....	+0.004	4512.906	−0.126	8.4
Ti 39.6890	4512.902	+0.004	.....	4512.906		
S 40.1840	4518.043	.....	±0.000	4518.198	−0.155	10.3
Ti 40.1989	Standard	±0.000	.....	4518.198		

Curvature Cor. + 0.0008 mm.

Mean −9.4
V_a +5.04
V_d +0.26
Reduction to Sun +5.30
Radial Velocity −4.1 km.

α *BOÖTIS*—B 304

Measured by F.
Power 17

S 29.1931	4399.778	.....	±0.000	4399.903	−0.125	−8.5
Ti 29.2110	Standard	±0.000	.....	4399.935		
S 29.9727	4406.666	.....	−0.010	4406.810	−0.154	10.5
S 30.4776	4411.165	.....	−0.019	4411.240	−0.094	6.4
Ti 30.4881	4411.259	−0.019	.....	4411.240		
Ti 32.2585	4427.278	−0.012	.....	4427.266		
S 32.2616	4427.307	.....	−0.012	4427.420	−0.125	8.5
S 33.8921	4442.402	.....	−0.016	4442.510	−0.124	8.4
Ti 34.0619	4443.993	−0.017	.....	4443.976		
S 34.4644	4447.780	.....	−0.027	4447.892	−0.139	9.4
Ti 34.6301	4449.345	−0.032	.....	4449.313		
S 34.7533	4450.511	.....	−0.029	4450.597	−0.115	7.8
Ti 35.2782	4455.500	−0.015	.....	4455.485		
S 35.4912	4457.535	.....	−0.015	4457.656	−0.136	9.2
Ti 35.4995	4457.615	−0.015	.....	4457.600		
Ti 37.9474	Standard	±0.000	.....	4481.438		
S 38.0304	4482.280	.....	±0.000	4482.376	−0.116	7.8
S 39.2647	4494.599	.....	−0.001	4494.738	−0.140	9.3
Ti 39.4351	4496.319	−0.001	.....	4496.318		
S 39.9256	4501.294	.....	−0.014	4501.422	−0.142	9.5
Ti 39.9418	4501.459	−0.014	.....	4501.445		
S 41.0466	4512.795	.....	−0.002	4512.906	−0.113	7.5
Ti 41.0575	4512.908	−0.002	.....	4512.906		
Ti 42.4516	4527.473	+0.017	.....	4527.490		
S 42.5673	4528.695	.....	+0.015	4528.798	−0.088	5.8

α *BOÖTIS*—B 304—*Continued*

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Wave-Length in Sun	Displacement	Velocity
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.
Ti 44.0811	4544.873	−0.009	.....	4544.864		
S 44.1872	4546.020	.....	−0.008	4546.129	−0.117	7.7
S 44.4471	4548.838	.....	−0.005	4548.938	−0.105	6.9
S 44.9271	4554.071	.....	−0.001	4554.211	−0.141	9.3
Ti 45.0724	Standard	±0.000	.....	4555.662		

Mean −8.3
Curvature Cor. −0.87
V_a + 5.04
V_d + 0.26
Reduction to Sun +5.30
Radial Velocity −3.8 km.

1902, April 3, G. M. T. $15^h\ 56^m$
Hour angle E $3^h\ 15^m$

α *BOÖTIS*—B 311
Star excellent; comparison excellent.

Measured by F.
Power 17

Ti 29.2136	Standard	±0.000	.....	4399.935		
S 29.1950	4399.772	.....	±0.000	4399.903	−0.131	−8.9
S 29.9756	4406.664	.....	−0.002	4406.810	−0.148	10.1
S 30.4744	4411.106	.....	−0.004	4411.240	−0.138	9.4
Ti 30.4898	4411.244	−0.004	.....	4411.240		
Ti 32.2622	4427.279	−0.013	.....	4427.266		
S 32.2639	4427.286	.....	−0.013	4427.420	−0.147	10.0
S 33.8967	4442.393	.....	±0.000	4442.510	−0.117	7.9
Ti 34.0658	4443.976	±0.000	.....	4443.976		
S 34.4718	4447.794	.....	−0.017	4447.892	−0.115	7.8
Ti 34.6350	4449.334	−0.021	.....	4449.313		
S 34.7568	4450.486	.....	−0.018	4450.597	−0.129	8.7
Ti 35.2843	4455.496	−0.011	.....	4455.485		
S 35.4991	4457.547	.....	−0.008	4457.656	−0.117	7.9
Ti 35.5055	4457.608	−0.008	.....	4457.600		
Ti 37.9557	Standard	±0.000	.....	4481.438		
S 38.0400	4482.273	.....	−0.001	4482.376	−0.104	7.0
S 39.2742	4494.602	.....	−0.015	4494.738	−0.151	10.1
Ti 39.4459	4496.335	−0.017	.....	4496.318		
S 39.9335	4501.277	.....	−0.016	4501.422	−0.161	10.7
Ti 39.9516	4501.461	−0.016	.....	4501.445		
S 41.0574	4512.800	.....	+0.007	4512.906	−0.099	6.6
Ti 41.0670	4512.899	+0.007	.....	4512.906		
Ti 44.0912	4544.848	+0.016	.....	4544.864		
S 44.1983	4546.005	.....	+0.014	4546.129	−0.110	7.3
S 44.4581	4548.820	.....	+0.010	4548.938	−0.108	7.1
S 44.9415	4554.086	.....	+0.002	4554.211	−0.123	8.1
Ti 45.0855	Standard	±0.000	.....	4555.662		

Curvature Cor. +0.0012 mm.

Mean −8.4
V_a +4.60
V_d +0.24
Reduction to Sun +4.84
Radial Velocity −3.6 km.

1902 May 7, G. M. T. $17^h\ 17^m$
Hour angle W $0^h\ 17^m$

α *BOÖTIS*—B 342
Star good; comparison good.

Measured by F.
Power 17

Ti 30.001	Standard	±0.000	.....	4427.266		
S 30.029	4427.530	.....	0.000	4427.420	+0.110	+7.4
S 30.751	4434.147	.....	−0.025	4434.021	+0.101	6.8
Ti 30.756	4434.193	−0.025	.....	4434.168		
S 32.238	4447.981	.....	−0.005	4447.892	+0.084	5.7
Ti 32.380	4449.317	−0.004	.....	4449.313		

α BOÖTIS — B 342 — *Continued*

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Moon Lines	Wave-Length in Sun	Displacement	Velocity
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.
S 32.989	4455.075	.....	−0.016	4454.993	+0.066	4.4
Ti 33.034	4455.503	−0.018	.....	4455.485		
Ti 33.254	4457.596	+0.004	.....	4457.600		
S 33.269	4457.740	.....	+0.004	4457.656	+0.088	5.9
Ti 34.127	4465.967	+0.008	.....	4465.975		
S 34.418	4468.780	.....	+0.008	4468.663	+0.125	8.4
S 35.189	4476.288	.....	+0.010	4476.214	+0.084	5.6
Ti 35.712	4481.427	+0.011	.....	4481.438		
S 35.818	4482.473	.....	+0.011	4482.376	+0.108	7.3
S 37.056	4494.809	.....	+0.001	4494.738	+0.072	4.8
Ti 37.206	Standard	±0.000	.....	4496.318		
S 37.716	4501.479	.....	+0.002	4501.422	+0.059	3.9
S 38.844	4513.012	.....	+0.006	4512.906	+0.112	7.4
Ti 40.233	4527.478	+0.012	.....	4527.490		
S 40.246	4527.615	.....	+0.012	4527.518	+0.109	7.2
S 40.389	4528.910	.....	+0.012	4528.798	+0.124	8.2
Ti 41.865	4544.852	+0.012	.....	4544.864		
S 41.992	4546.222	.....	+0.010	4546.129	+0.103	6.8
S 42.736	4554.297	.....	+0.001	4554.211	+0.087	5.7
Ti 42.861	Standard	±0.000	.....	4555.662		

Curvature Cor. +0.001 mm.

Mean +6.4
V_a −9.90
V_d −0.03
Reduction to Sun −9.93
Radial Velocity −3.6 km.

α BOÖTIS—B 371

1902, June 26, G. M. T. 15h 30m — Measured by A.
Hour angle W 1h 34m — Star slightly weak; comparison good. — Power 17

Ti 32.6666	Standard	±0.000	.....	4427.266		
S 32.8568	4429.004	.....	±0.000	4428.711	+0.293	+19.8
S 34.3503	4442.805	.....	±0.000	4442.510	+0.295	19.9
Ti 34.4758	4443.976	±0.000	.....	4443.976		
S 34.5112	4444.307	.....	±0.000	4443.976	+0.331	22.3
S 34.9280	4448.217	.....	−0.006	4447.892	+0.319	21.5
Ti 35.0452	4449.320	−0.007	.....	4449.313		
Ti 35.9202	4457.613	−0.013	.....	4457.600		
S 36.2514	4460.779	.....	−0.009	4460.460	+0.310	20.8
Ti 37.0699	Standard	±0.000	.....	4468.663		
S 37.1045	4468.998	.....	±0.000	4468.663	+0.335	22.5
S 37.8768	4476.523	.....	−0.013	4476.214	+0.396	19.8
Ti 38.3790	4481.460	−0.022	.....	4481.438		
S 38.5036	4482.690	.....	−0.023	4482.376	+0.291	19.5
Ti 39.8726	4496.348	−0.030	.....	4496.318		
S 39.9741	4497.371	.....	+0.024	4497.046	+0.301	20.1
Ti 40.3770	4501.447	−0.002	.....	4501.445		
S 40.4046	4501.727	.....	−0.002	4501.422	+0.303	20.2
Ti 41.4987	4512.917	−0.011	.....	4512.906		
S 41.7730	4515.750	.....	−0.009	4515.475	+0.266	17.7
Ti 42.8987	4527.492	−0.002	.....	4527.490		
S 43.0539	4529.126	.....	−0.004	4528.798	+0.324	21.5
Ti 44.9110	4548.964	−0.026	.....	4548.938		
S 44.9386	4549.263	.....	−0.026	4548.938	+0.299	19.7
S 45.4204	4554.499	.....	−0.004	4554.211	+0.284	18.7
Ti 45.5269	Standard	±0.000	.....	4555.662		

Curvature Cor. +0.0008 mm.

Mean +20.3
V_a −23.85
V_d −0.13
Reduction to Sun −23.98
Radial Velocity −3.7 km.

α *BOÖTIS*—A 373

1902, September 6, G. M. T. $13^h\ 43^m$ — Measured by A.
Hour angle W $4^h\ 38^m$ — Star good; comparison good. — Power 28

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Wave-Length in Sun	Displacement	Velocity
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.
Ti 29.1810	Standard	±0.000	.....	4427.266		
S 20.2066	4427.580	.....	±0.000	4427.420	+0.160	+10.8
S 29.3129	4428.886	.....	+0.001	4428.711	+0.176	11.9
S 29.8890	4436.008	.....	+0.008	4435.851	+0.165	11.2
S 30.4227	4442.673	.....	+0.014	4442.510	+0.177	11.9
Ti 30.5252	4443.961	+0.015	.....	4443.976		
S 30.5392	4444.137	.....	+0.015	4443.976	+0.176	11.9
S 30.8512	4448.072	.....	−0.003	4447.892	+0.177	11.9
Ti 30.9499	4449.322	−0.009	.....	4449.313		
Ti 31.4348	4455.494	−0.009	.....	4455.485		
S 31.4904	4456.205	.....	−0.008	4456.030	+0.167	11.2
Ti 32.2483	Standard	±0.000	.....	4465.975		
S 32.3175	4466.874	.....	±0.000	4466.701	+0.173	11.6
S 32.9524	4475.176	.....	+0.005	4475.026	+0.155	10.4
S 33.0439	4476.381	.....	+0.006	4476.214	+0.173	11.6
Ti 33.4257	4481.430	+0.008	.....	4481.438		
S 33.5085	4482.530	.....	+0.009	4482.376	+0.163	10.9
S 34.4310	4494.900	.....	+0.015	4494.738	+0.177	11.8
Ti 34.5345	4496.302	+0.016	.....	4496.318		
S 34.5999	4497.189	.....	+0.013	4497.046	+0.156	10.4
Ti 34.9126	4501.446	−0.001	.....	4501.445		
S 34.9224	4501.579	.....	−0.001	4501.422	+0.156	10.4
Ti 35.7445	4512.895	+0.011	.....	4512.906		
S 35.7562	4513.057	.....	+0.011	4512.906	+0.162	10.8
S 35.9421	4515.642	.....	+0.009	4515.475	+0.176	11.7
Ti 36.7859	Standard	±0.000	.....	4527.490		
S 36.8902	4528.968	.....	±0.000	4528.798	+0.170	11.3

Curvature Cor. +0.0005 mm.

Mean		+11.3
V_a	−15.79	
V_d	− 0.30	
Reduction to Sun		−16.09
Radial Velocity		− 4.8 km.

SUMMARY OF MEASURES OF α *BOÖTIS*

Plate	Date	Adams	No. of Lines	Frost	No. of Lines
B 293	1902, March 12	−3.6	21	.....	..
B 300	March 13	−4.3	18	−5.7	19
A 336	March 26	−5.4	17	.....	..
B 304	April 2	−4.1	18	−3.8	16
B 311	April 3	.....	..	−3.6	15
B 342	May 7	.....	..	−3.6	15
B 371	June 26	−3.7	14	.....	..
A 373	Sept. 6	−4.8	17	.....	..
Mean		−4.3		−4.2	

Mean of 8 plates −4.2 km.
Mean of all measures −4.3 km.

The results of other observers for this star are as follows:

Vogel and Scheiner	−7.7
Belopolsky	−5.7
Keeler (visual)	−6.8
Newall	−5.9

PLATES OF STARS OF THE *ORION* TYPE

The detailed measurements on the different plates on the *Orion* stars follow. The stars are arranged in order of right ascension, and the separate plates of the same star in chronological order. The magnitudes of the stars are from the Harvard Photometry, and the spectral classes are according to Miss Maury's classification (*Annals of Harvard College Observatory*, Vol. XXVIII, 1898). The form of tabulation is the same as for the control plates, and all necessary explanations are found in the introductory note to those plates, and in the general discussion of the method of measurement (p. 7).

1. γ *PEGASI*

(R. A. = $0^h\ 8^m$; Dec. = $+14°\ 38'$; Mag. 3.3; Class IVa)

Eight plates of this star have been measured, seven by A., and five by F., with four common to the two observers. As compared with the more recent plates both the stellar and comparison spectra of the earlier plates are distinctly inferior. The spectrum of this star is much better adapted to accurate measurement than that of the average star of the *Orion* type. All of the lines are comparatively narrow, and numerous oxygen and nitrogen lines are present.

γ *PEGASI*—A 215

1901, September 5, G. M. T. $21^h\ 28^m$ — Measured by A.
Hour angle W $2^h\ 22^m$ — Star strong; comparison fair. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 25.3921	Standard	±0.000		4338.084			
S 26.4567	4349.438		−0.007	4349.541	−0.110	−7.6	1
Ti 30.5625	4395.237	−0.036		4395.201			
S 34.1140	4437.639		−0.005	4437.718	−0.084	5.7	1
Ti 34.6256	Standard	±0.000		4443.976			
Ti 35.0540	4449.327	−0.014		4449.313			
Ti 36.5711	4468.630	+0.033		4468.663			
S 36.7924	4471.493		+0.036	4471.676	−0.147	9.9	1
S 37.5336	4481.163		+0.046	4481.400	−0.191	12.8	1
Ti 37.5510	4481.392	+0.046		4481.438			
Ti 42.7055	4552.627	+0.005		4552.632			
S 42.7083	4552.668		+0.005	4552.750	−0.077	5.1	1
Ti 43.4780	Standard	±0.000		4563.939			
S 43.7430	4567.860		±0.000	4567.950	−0.090	5.9	1

Curvature Cor. +0.0001 mm.

Weighted mean − 7.8 — Mean −7.8

V_a +11.66
V_d − 0.19

Reduction to Sun +11.47
Radial Velocity + 3.7 km.

γ *PEGASI*—A 218

1901, September 6, G. M. T. $17^h\ 7^m$
Hour angle E $2^h\ 20^m$

Star strong; comparison good.

Measured by A.
Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 23.8216	Standard	±0.000	.....	4338.084	.....	.....	..
S 24.0582	4340.589	.....	−0.002	4340.634	−0.047	−3.2	1
S 28.3715	4388.086	.....	−0.034	4388.100	−0.048	3.3	1
Ti 28.9937	4395.240	−0.039	.....	4395.201	.....	.....	..
S 30.6752	4414.978	.....	−0.037	4415.076	−0.135	9.2	1
Ti 31.7013	4427.301	−0.035	.....	4427.266	.....	.....	..
S 32.5469	4437.641	.....	−0.017	4437.718	−0.094	6.4	2
Ti 33.0591	4443.982	−0.006	.....	4443.976	.....	.....	..
Ti 33.4860	Standard	±0.000	.....	4449.313	.....	.....	..
S 35.2302	4471.539	.....	+0.014	4471.676	−0.123	8.2	2
S 35.9751	4481.254	.....	+0.021	4481.400	−0.125	8.4	3
Ti 35.9875	4481.417	+0.021	.....	4481.438	.....	.....	..
Ti 41.9166	Standard	±0.000	.....	4563.939	.....	.....	..
S 42.1850	4567.907	.....	±0.000	4567.950	−0.049	3.2	2

Curvature Cor. +0.0001 mm.

Weighted mean − 6.4
V_a +11.29
V_d + 0.17
Reduction to Sun +11.46
Radial velocity + 5.1 km.

γ *PEGASI*—A 233

1901, September 18, G. M. T. $14^h\ 50^m$
Hour angle E $3^h\ 22^m$

Star good; comparison fair.

Measured by A.
Power 21

Ti 18.6731	Standard	±0.000	.....	4338.084			
S 18.9045	4340.549	.....	−0.002	4340.634	−0.087	−6.0	1
S 23.1969	4388.083	.....	−0.032	4388.100	−0.049	3.4	1
Ti 23.8163	4395.239	−0.038	.....	4395.201			
S 25.5017	4415.111	.....	−0.050	4415.076	−0.015	1.0	2
S 25.6718	4417.151	.....	−0.051	4417.121	−0.021	1.4	2
Ti 25.7371	4417.935	−0.051	.....	4417.884			
S 27.3544	4437.660	.....	−0.010	4437.718	−0.068	4.6	2
Ti 27.8622	4443.974	+0.002	.....	4443.976			
Ti 29.8037	Standard	±0.000	.....	4468.663			
S 30.0261	4471.548	.....	+0.004	4471.676	−0.124	8.3	1
S 30.7733	4481.330	.....	+0.016	4481.400	−0.054	3.6	3
Ti 30.7803	4481.422	+0.016	.....	4481.438			
Ti 35.9145	4552.542	+0.090	.....	4552.632			
S 35.9204	4552.627	.....	+0.090	4552.750	−0.033	2.2	2
Ti 36.6889	4563.899	+0.040	.....	4563.939			
S 36.9529	4567.810	.....	+0.040	4567.950	−0.100	6.6	1
Ti 37.2418	4572.115	+0.041	.....	4572.156			
Ti 40.1867	Standard	±0.000	.....	4617.452			
S 41.0140	4630.687	.....	±0.000	4630.703	−0.016	−1.0	2

Curvature Cor. +0.0001 mm.

Weighted mean − 3.3 Mean −3.8
V_a + 5.71
V_d + 0.25
Reduction to Sun + 5.96
Radial Velocity + 2.7 km.

γ PEGASI—A 233

Measured by F.
Power 17

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 29.999	Standard	±0.000	.....	4338.084			
S 30.236	4340.613	.....	−0.001	4340.634	−0.022	−1.5	1
Ti 35.551	4399.987	−0.052	.....	4399.935			
S 36.829	4415.102	.....	−0.054	4415.076	−0.028	−1.9	2
S 36.709	4417.175	.....	−0.054	4417.121	0.000	0.0	2
Ti 37.065	4417.938	−0.054	.....	4417.884			
Ti 37.839	4427.303	−0.037	.....	4427.266			
S 38.684	4437.684	.....	−0.029	4437.718	−0.063	−4.3	2
Ti 39.192	4444.001	−0.025	.....	4443.976			
Ti 41.133	4468.680	−0.017	.....	4468.663			
S 41.359	4471.609	.....	−0.014	4471.676	−0.081	−5.4	3
Ti 42.110	Standard	±0.000	.....	4481.438			
S 42.102	4481.335	.....	±0.000	4481.400	−0.065	−4.4	3
Ti 47.245	4552.592	+0.040	.....	4552.632			
S 47.252	4552.690	.....	+0.040	4552.750	−0.020	−1.3	2
Ti 48.018	4553.930	+0.009	.....	4563.939			
S 48.284	4567.872	.....	+0.006	4567.950	−0.072	−4.7	2
Ti 48.571	Standard	±0.000	.....	4572.156			

Weighted mean −3.3 Mean—2.9
Curvature Cor. −0.24
V_a +5.71
V_d +0.25
Reduction to Sun +5.96
Radial Velocity +2.5 km.

γ PEGASI—A 245

1902, September 26, G. M. T. $14^h\ 5^m$
Hour angle E $3^h\ 38^m$

Star fair; comparison strong.

Measured by A
Power 21

Ti 32.3644	4386.958	+0.049	.....	4387.007			
S 32.4662	4388.125	.....	+0.042	4388.100	+0.067	+4.6	1
Ti 33.4861	Standard	±0.000	.....	4399.935			
S 34.7662	4415.061	.....	−0.016	4415.076	−0.031	−2.1	1
S 34.9382	4417.119	.....	−0.018	4417.121	−0.020	−1.4	1
Ti 35.0036	4417.903	−0.019	.....	4417.884			
He 39.3113	4471.661	+0.015	.....	4471.676			
S 39.3137	4471.692	.....	+0.015	4471.676	+0.031	+2.1	1
S 40.0624	4481.476	.....	−0.040	4481.400	+0.036	+2.4	3
Ti 40.0625	4481.478	−0.040	.....	4481.438			
Ti 43.4488	Standard	±0.000	.....	4527.490			
Ti 45.2104	4552.632	±0.000	.....	4552.632			
S 45.2191	4552.759	.....	±0.000	4552.750	+0.009	+0.6	2
Ti 45.9822	4563.923	+0.016	.....	4563.939			
S 46.2587	4568.010	.....	+0.003	4567.950	+0.063	+4.1	2
Ti 46.5383	4572.165	−0.009	.....	4572.156			
S 46.7283	4575.002	.....	−0.008	4574.900	+0.094	+6.2	1
Ti 49.4881	Standard	±0.000	.....	4617.452			

Curvature Cor. +0.0001 mm.

Weighted mean +2.1 Mean +2.1
V_a +1.80
V_d +0.27
Reduction to Sun +2.07
Radial Velocity +4.2 km.

1901, October 16, G. M. T. $12^h\ 46^m$ — γ *PEGASI*—B 194 — Measured by F.
Hour angle W $2^h\ 20^m$ — Power 17

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 21.834	Standard	±0.000	.....	4338.084			
S 22.178	4340.812	.....	−0.002	4340.634	+0.176	+12.2	1
S 27.956	4388.406	.....	−0.063	4388.100	+0.243	16.6	3
Ti 28.756	4395.274	−0.073	.....	4395.201			
Ti 29.305	4400.038	−0.100	.....	4399.935			
S 31.052	4415.399	.....	−0.084	4415.076	+0.239	16.2	2
S 31.285	4417.480	.....	−0.082	4417.121	+0.277	18.8	2
Ti 31.340	4417.966	−0.082	.....	4417.884			
Ti 32.384	4427.361	−0.095	.....	4427.266			
S 33.550	4438.004	.....	−0.075	4437.718	+0.211	14.3	3
Ti 34.203	4444.037	−0.061	.....	4443.976			
Ti 36.816	4468.721	−0.058	.....	4468.663			
He 37.118	4471.636	+0.040	.....	4471.676			
S 37.158	4472.018	.....	−0.052	4471.676	+0.290	19.4	4
Ti 38.130	4481.472	−0.034	.....	4481.438			
S 38.142	4481.595	.....	−0.034	4481.400	+0.161	10.8	5
Ti 41.270	Standard	±0.000	.....	4512.906			
Ti 42.680	4527.471	+0.019	.....	4527.490			
Ti 45.045	4552.591	+0.041	.....	4552.632			
S 45.077	4552.936	.....	+0.041	4552.750	+0.227	15.0	4
Ti 46.085	4563.911	+0.028	.....	4563.939			
S 46.471	4568.156	.....	+0.034	4567.950	+0.240	15.8	3
Ti 46.829	4572.116	+0.040	.....	4572.156			
S 47.091	4575.026	.....	+0.039	4574.900	+0.200	13.1	2
Ti 48.431	4590.091	+0.035	.....	4590.126			
S 48.532	4591.233	.....	+0.036	4591.066	+0.203	13.3	
S 49.002	4596.602	.....	+0.040	4596.291	+0.351	22.9	3
Ti 50.793	4617.392	+0.060	.....	4617.452			
S 51.926	4630.844	.....	+0.051	4630.703	+0.192	12.1	1
S 53.466	4649.493	.....	+0.038	4649.250	+0.281	18.1	3
Ti 54.044	4656.610	+0.034	.....	4656.644			
S 54.478	4661.990	.....	+0.032	4661.728	+0.294	18.9	4
Ti 54.938	4667.739	+0.029	.....	4667.768			
Ti 56.071	Standard	±0.000	.....	4682.088			
He 58.478	4713.414	−0.162	.....	4713.308			
S 58.496	4713.659	.....	−0.162	4713.308	+0.245	15.6	5

Weighted mean +16.30 — Mean +15.8
Curvature Cor. — 0.27
V_a −8.21
V_d −0.19
Reduction to Sun — 8.40
Radial Velocity + 7.6 km.

1901, November 27, G. M. T. $12^h\ 11^m$ — γ *PEGASI*—B 246 — Measured by A.
Hour angle E $1^h\ 27^m$ — Star good; comparison good. — Power 21

Ti 24.2438	Standard	±0.000	.....	4387.007			
S 24.4247	4388.571	.....	±0.000	4388.100	+0.471	+32.2	2
Ti 26.9971	4411.222	+0.018	.....	4411.240			
S 27.4696	4415.466	.....	+0.016	4415.076	+0.406	27.6	3
Ti 33.1500	4468.669	−0.006	.....	4468.663			
S 33.5051	4472.134	.....	−0.004	4471.676	+0.454	30.4	2
Ti 34.4500	Standard	±0.000	.....	4481.438			
S 34.4929	4481.863	.....	±0.000	4481.400	+0.463	31.0	2
Ti 41.2867	4552.593	+0.039	.....	4552.632			
S 41.3428	4553.206	.....	+0.039	4552.750	+0.495	32.6	2
Ti 42.3138	4563.903	+0.036	.....	4563.939			
S 42.7187	4568.410	.....	+0.019	4567.950	+0.479	31.4	3
Ti 43.0535	Standard	±0.000	.....	4572.156			

Curvature Cor. +0.0008 mm. — Weighted mean +30.7 — Mean +30.9
V_a −24.93
V_d + 0.12
Reduction to Sun −24.81
Radial Velocity + 5.9 km.

γ *PEGASI*—B 246

Measured by F.
Power 17

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
S 29.961	4367.455	.....	+0.057	4367.012	+0.500	+34.3	1
Ti 30.000	4367.782	+0.057	.....	4367.839			
Ti 32.259	Standard	+0.001	.....	4387.007			
S 32.440	4388.571	.....	−0.001	4388.100	+0.470	32.1	2
S 35.489	4415.497	.....	−0.042	4415.076	+0.379	25.7	3
Ti 35.759	4417.934	−0.050	.....	4417.884			
Ti 37.534	4434.182	−0.014	.....	4434.168			
S 37.972	4438.251	.....	−0.029	4437.718	+0.504	34.1	2
Ti 38.219	4440.551	−0.036	.....	4440.515			
Ti 40.892	4465.998	−0.023	.....	4465.975			
Ti 41.451	4471.439	−0.031	.....	4471.408			
S 41.532	4472.231	.....	−0.019	4471.676	+0.536	35.9	2
Ti 42.467	Standard	+0.001	.....	4481.438			
S 42.514	4481.902	.....	+0.001	4481.400	+0.503	33.7	3
Ti 49.306	4552.612	+0.020	.....	4552.632			
S 49.362	4553.241	.....	+0.017	4552.750	+0.491	32.3	2
Ti 49.584	4555.656	+0.005	.....	4555.662			
Ti 52.654	Standard	+0.001	.....	4590.126			
S 52.789	4591.682		±0.000	4591.066	+0.616	40.2	1

Weighted mean +32.6 — Mean +33.5
Curvature Cor. − 0.90
V_a −24.93
V_d + 0.12
Reduction to Sun −24.81
Radial Velocity + 6.9 km.

γ *PEGASI*—B 395

1902, August 22, G. M. T. $20^h\ 40^m$
Hour angle W $0^h\ 40^m$

Star good; comparison good.

Measured by A.
Power 17

S 25.3176	4387.943	.....	±0.000	4388.100	−0.157	−10.7	1
Ti 26.1587	Standard	±0.000		4395.201			
S 28.3946	4414.893	.....	−0.024	4415.076	−0.207	14.2	2
S 28.6302	4417.002	.....	−0.027	4417.121	−0.146	9.9	1
Ti 28.7316	4417.912	−0.028	.....	4417.884			
Ti 29.7690	4427.301	−0.035	.....	4427.266			
S 30.8940	4437.613	.....	−0.002	4437.718	−0.107	7.2	1
Ti 31.5778	4443.964	+0.012	.....	4443.976			
Ti 34.1776	Standard	±0.000	.....	4468.663			
S 34.4670	4471.468	.....	+0.003	4471.676	−0.205	13.8	2
S 35.4614	4481.192	.....	+0.015	4481.400	−0.193	12.9	3
Ti 35.4849	4481.423	+0.015	.....	4481.438			
S 42.3591	4552.566	.....	+0.013	4552.750	−0.171	11.3	3
Ti 42.3640	4552.619	+0.013	.....	4552.632			
Ti 43.3973	4563.942	−0.003	.....	4563.939			
S 43.7499	4567.846	.....	−0.002	4567.950	−0.106	7.0	2
Ti 44.1371	Standard	±0.000	.....	4572.156			
S 44.3630	4574.682	.....	±0.000	4574.900	−0.218	14.3	2

Curvature Cor. +0.0009 mm.

Weighted mean −11.6 — Mean −11.2
V_a +17.60
V_d − 0.06
Reduction to Sun +17.54
Radial Velocity + 5.9 km.

γ *PEGASI*—B 395 Measured by F.
Power 17

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 30.0036	4338.093	−0.009	.....	4338.084			
S 30.2982	4340.438	.....	−0.006	4340.634	−0.202	−14.0	2
Cr 30.8273	Standard	±0.000	.....	4344.670			
Cr 34.0985	4371.478	−0.036	.....	4371.442			
S 36.0509	4388.025	.....	−0.038	4388.100	−0.113	7.7	3
Ti 36.8869	4395.240	−0.039	.....	4395.201			
S 39.1255	4414.957	.....	−0.059	4415.076	−0.178	12.1	2
Ti 39.4590	4417.945	−0.061	.....	4417.884			
Ti 40.4960	4427.321	−0.055	.....	4427.266			
S 41.6236	4437.667	.....	−0.049	4437.718	−0.100	6.8	3
Ti 42.3077	4444.021	−0.045	.....	4443.976			
Ti 44.9038	4468.682	−0.019	.....	4468.663			
S 45.1978	4471.531	.....	−0.015	4471.676	−0.160	10.7	3
S 46.1916	4481.246	.....	±0.000	4481.400	−0.154	10.3	4
Ti 46.2109	Standard	±0.000	.....	4481.438			
S 53.0861	4552.573	.....	+0.007	4552.750	−0.170	11.2	3
Ti 53.0909	4552.625	+0.007	.....	4552.632			
Ti 53.3687	4555.651	+0.011	.....	4555.662			
Ti 54.1247	4563.949	−0.010	.....	4563.939			
S 54.4745	4567.820	.....	±0.000	4567.950	−0.130	8.5	3
Ti 54.8641	Standard	±0.000	.....	4572.156			
S 55.0962	4574.750	.....	±0.000	4574.900	−0.150	9.8	2

Weighted mean — 9.9 Mean —10.1
Curvature Cor. — 0.82
V_a +17.60
V_d — 0.06
Reduction to Sun +17.54
Radial Velocity + 6.8 km.

1902, October 9, G. M. T. $17^h\,53^m$ γ *PEGASI*—B 419 Measured by A.
Hour angle W. $1^h\,5^m$ Star good; comparison good. Power 21

Ti 22.0428	Standard	±0.000	.....	4338.084			
S 22.3850	4340.812	.....	−0.001	4340.634	+0.177	+12.2	1
S 28.1141	4388.306	.....	−0.014	4388.100	+0.192	13.1	1
Ti 28.9134	4395.217	−0.016	.....	4395.201			
Ti 29.4541	4399.935	±0.000	.....	4399.935			
S 31.1782	4415.206	.....	−0.006	4415.076	+0.124	8.4	2
S 31.4124	4417.308	.....	−0.007	4417.121	+0.180	12.2	1
Ti 31.4773	4417.891	−0.007	.....	4417.884			
Ti 32.5113	4427.258	+0.008	.....	4427.266			
S 33.6671	4437.885	.....	+0.003	4437.718	+0.170	11.5	2
Ti 34.3214	Standard	±0.000	.....	4443.976			
Ti 36.9141	4468.657	+0.006	.....	4468.663			
S 37.2371	4471.795	.....	+0.012	4471.676	+0.131	8.8	3
Ti 38.2175	4481.406	+0.032	.....	4481.438			
S 38.2291	4481.521	.....	+0.032	4481.400	+0.153	10.2	5
Ti 45.0835	4552.625	+0.007	.....	4552.632			
S 45.1120	4552.935	.....	+0.007	4552.750	+0.192	12.6	2
Ti 46.1136	Standard	±0.000	.....	4563.939			
S 46.4929	4568.149	.....	−0.008	4567.950	+0.191	12.5	4
Ti 46.8533	4572.172	−0.016	.....	4572.156			

Curvature Cor. +0.0008 mm. Weighted mean +11.0 Mean +11.3
V_a — 4.63
V_d — 0.09
Reduction to Sun — 4.72
Radial Velocity + 6.3 km.

γ PEGASI—B 419 Measured by F. Power 17

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 29.9510	4387.035	−0.028	.....	4387.007			
S 30.0991	4388.309	.....	−0.025	4388.100	+0.184	+12.6	1
Ti 30.8962	4395.207	−0.006	.....	4395.201			
Ti 31.4378	Standard	±0.000	.....	4399.935			
S 33.1676	4415.266	.....	−0.003	4415.076	+0.187	12.7	2
Ti 33.4584	4417.878	+0.006	.....	4417.884			
Ti 34.4958	4427.279	−0.013	.....	4427.266			
S 35.6534	4437.925	.....	−0.004	4437.718	+0.203	13.7	1½
Ti 36.3037	4443.980	−0.004	.....	4443.976			
Ti 38.8970	4468.667	−0.004	.....	4468.663			
Ti 39.1795	4471.410	−0.002	.....	4471.408			
S 39.2222	4471.825	.....	−0.002	4471.676	+0.147	9.9	2½
Ti 40.2030	Standard	±0.000	.....	4481.438			
S 40.2149	4481.556	.....	±0.000	4481.400	+0.156	10.4	3
Ti 47.0704	4552.625	+0.007	.....	4552.632			
S 47.0981	4552.928	.....	+0.007	4552.750	+0.183	12.0	2
Ti 48.1009	4563.931	+0.008	.....	4563.939			
S 48.4826	4568.163	.....	+0.004	4567.950	+0.217	14.2	2
Ti 48.8408	Standard	±0.000	.....	4572.156			
S 49.1044	4575.108	.....	+0.001	4574.900	+0.209	13.7	1
Ti 50.4284	4590.113	+0.013	.....	4590.126			

Curvature Cor. +0.0013 mm. Weighted mean +12.0 Mean +12.4

V_a −4.63

V_d −0.09

Reduction to Sun − 4.72

Radial Velocity + 7.3 km.

SUMMARY OF MEASURES OF *γ PEGASI*

Plate	Date	Adams	No. of Lines	Frost	No. of Lines
A 215	1901, Sept. 5	+3.7	6	.....	..
A 218	Sept. 6	+5.1	7	.....	..
A 233	Sept. 18	+2.7	10	+2.5	8
A 245	Sept. 26	+4.2	8	.....	..
B 194	Oct. 16	.....	..	+7.6	16
B 246	Nov. 27	+5.9	6	+6.9	8
B 395	1902, Aug. 22	+5.9	9	+6.8	9
B 419	Oct. 9	+6.3	9	+7.3	8
	Mean	+4.8		+6.2	

Mean of 8 plates +5.3 km.
Mean of all measures +5.4 km.

2. *ζ CASSIOPEIAE*

(R. A. = 0h 31m; Dec. = +53° 21′; Mag. 3.7; Class IV*a*)

Four plates of this star have been measured, with two common to the two observers. The spectrum has much the same lines as in the case of *γ Pegasi*, but the lines are considerably broader, and accurate measurement is consequently more difficult.

ζ *CASSIOPEIAE*—A 281

1901, October 31, G. M. T. $13^h\ 50^m$ — Measured by F.
Hour angle E $0^h\ 20^m$ — Star fair; comparison fair. — Power 17

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 29.4825	4338.046	+0.038	.....	4338.084			
S 29.7341	4340.725	.....	+0.038	4340.634	+0.129	+8.9	1
Ti 30.0789	4344.414	+0.037	.....	4344.451			
S 32.1530	4367.070	.....	+0.001	4367.012	+0.059	+4.0	½
Ti 32.2221	Standard	±0.000	.....	4367.839			
Ti 33.9222	4387.046	−0.039	.....	4387.007			
He 34.0167	4388.131	−0.031	.....	4388.100			
S 34.0234	4388.208	.....	−0.036	4388.100	+0.072	+4.9	2
Ti 35.4240	4404.496	−0.063	.....	4404.433			
S 36.3179	4415.105	.....	−0.072	4415.076	−0.043	−2.9	2
Ti 36.5559	4417.958	−0.074	.....	4417.884			
Ti 37.8895	4434.174	−0.006	.....	4434.168			
S 38.1825	4437.790	.....	+0.001	4437.718	+0.073	+4.9	1½
Ti 38.4019	4440.510	+0.005	.....	4440.515			
Ti 40.4150	4465.983	−0.008	.....	4465.975			
S 40.8538	4471.663	.....	−0.005	4471.676	−0.018	−1.2	3
Ti 41.6007	Standard	±0.000	.....	4481.438			
S 41.6002	4481.431	.....	±0.000	4481.400	+0.031	+2.1	4
Ti 46.7395	4552.599	+0.033	.....	4552.632			
S 46.7538	4552.807	.....	+0.033	4552.750	+0.090	+5.9	2
Ti 46.9467	4555.620	+0.042	.....	4555.662			
Ti 47.5099	4563.894	+0.045	.....	4563.939			
S 47.7895	4568.036	.....	+0.038	4567.950	+0.124	+8.1	1
Ti 49.2547	Standard	±0.000	.....	4590.126			
Ti 51.7687	Standard	±0.000	.....	4629.521			
S 51.8431	4630.717	.....	±0.000	4630.703	+0.014	+0.9	2
Ti 54.0936	Standard	±0.000	.....	4667.768			
Ti 56.5594	Standard	±0.000	.....	4710.368			
He 56.7282	4713.365	−0.057	.....	4713.308			
S 56.7296	4713.391	.....	−0.028	4713.308	+0.055	+3.5	3

Curvature Cor. +0.0009 mm. — Weighted mean +2.7 — Mean +3.6

V_a −1.90
V_d +0.02

Reduction to Sun −1.88
Radial Velocity +0.8 km.

ζ *CASSIOPEIAE*—B 211

1901, November 7, G. M. T. $14^h\ 43^m$ — Measured by A.
Hour angle E $0^h\ 43^m$ — Star good; comparison on but one side of star spectrum. — Power 21

Ti 19.3141	Standard	±0.000	.....	4338.084			
Ti 25.2765	4387.103	−0.096	.....	4387.007			
S 25.4128	4388.268	.....	−0.094	4388.100	+0.074	+5.1	2
S 30.9939	4437.819	.....	−0.010	4437.718	+0.091	6.2	1
Ti 31.6579	Standard	±0.000	.....	4443.976			
Ti 34.2661	4468.670	−0.007	.....	4468.663			
S 34.5904	4471.803	.....	±0.000	4471.676	+0.127	8.5	3
Ti 35.5771	4481.413	+0.025	.....	4481.438			
S 35.5847	4481.497	.....	+0.025	4481.400	+0.122	8.2	2
Ti 42.4790	4552.614	+0.018	.....	4552.632			
S 42.5045	4552.890	.....	+0.018	4552.750	+0.158	10.4	2
Ti 43.5160	Standard	±0.000	.....	4563.939			
S 43.8931	4568.101	.....	±0.000	4567.750	+0.151	9.9	1
Ti 44.2586	4572.157	−0.001	.....	4572.156			
S 44.5133	4574.996	.....	−0.001	4574.900	+0.095	6.2	1

Curvature Cor. +0.0002 mm. — Weighted mean +9.7 — Mean +7.8

V_a −4.48
V_d +0.04

Reduction to Sun −4.44
Radial Velocity +3.5 km.

ζ *CASSIOPEIAE*—B 248

1901, November 27, G. M. T. $16^h\ 48^m$ — Measured by A.
Hour angle W $2^h\ 49^m$ — Star good; comparison good. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 25.8586	Standard	±0.000	.....	4387.007			
S 25.0051	4388.274	.....	+0.002	4388.100	+0.176	+12.0	3
Ti 28.6093	4411.207	+0.033	.....	4411.240			
S 29.2890	4417.324	.....	+0.021	4417.121	+0.224	15.2	1
Ti 31.1310	4434.181	−0.013	.....	4434.168			
S 31.5420	4438.000	.....	±0.000	4437.718	+0.282	19.1	3
Ti 32.1785	4443.956	+0.020	.....	4443.976			
Ti 34.7653	4468.700	−0.037	.....	4468.663			
S 35.0971	4471.938	.....	−0.028	4471.676	+0.234	15.7	2
Ti 36.0618	Standard	±0.000	.....	4481.438			
S 36.0736	4481.555	.....	±0.000	4481.400	+0.155	10.4	3
Ti 42.8983	4552.605	+0.027	.....	4552.632			
S 42.9342	4552.998	.....	+0.027	4552.750	+0.275	18.1	2
Ti 43.9288	4563.956	−0.017	.....	4563.939			
S 44.3155	4568.259	.....	−0.013	4567.950	+0.296	19.4	1
S 44.9318	4575.170	.....	−0.010	4574.900	+0.260	17.0	1
Ti 46.2466	Standard	±0.000	.....	4590.126			
S 46.8046	4596.563	.....	±0.000	4596.291	+0.272	17.8	2

Curvature Cor. +0.0009 mm. — Weighted mean +15.5 — Mean +16.1

V_a −11.41
V_d − 0.14

Reduction to Sun −11.55
Radial Velocity + 4.0 km.

ζ *CASSIOPEIAE*—B 248

Measured by F.
Power 12

Ti 34.9060	4340.689	.....	+0.108	4340.634	+0.163	+11.3	2
S 34.9975	4341.425	+0.105	.....	4341.530			
Ti 40.4650	Standard	±0.000	.....	4387.007			
S 40.6127	4388.284	.....	+0.005	4388.100	+0.189	12.9	3
Ti 42.4605	4404.465	+0.032	.....	4404.433			
S 43.6605	4415.187	.....	+0.027	4415.076	+0.138	9.4	½
Ti 45.7405	4434.184	+0.016	.....	4434.168			
S 46.1508	4437.994	.....	+0.010	4437.718	+0.286	19.3	1
Ti 49.0985	4466.007	−0.032	.....	4465.975			
S 49.7048	4471.911	.....	−0.022	4471.676	+0.213	14.3	3
Ti 50.6725	Standard	±0.000	.....	4481.438			
S 50.6848	4481.560	.....	±0.000	4481.400	+0.160	10.7	4
Ti 57.5090	4552.602	+0.030	.....	4552.632			
S 57.5480	4553.028	.....	+0.030	4552.750	+0.308	20.3	3
S 58.9235	4568.228	.....	+0.017	4567.950	+0.195	12.8	2
Ti 60.8570	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0015 mm. — Weighted mean +13.9 — Mean +13.9

V_a −11.41
V_d − 0.14

Reduction to Sun −11.55
Radial Velocity + 2.4 km.

1902, July 22, G. M. T. $19^h\ 10^m$ — ζ *CASSIOPEIAE* — A 355 — Measured by A.
Hour angle E $3^h\ 10^m$ — Star good; comparison imperfect. — Power 17

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 24.1893	Standard	±0.000	.....	4338.084			
S 24.4017	4340.360	.....	−0.001	4340.634	−0.275	−19.5	3
S 28.6706	4387.926	.....	−0.023	4388.100	−0.197	13.5	2
Ti 29.7021	4399.963	−0.028	.....	4399.935			
Ti 31.9750	4427.286	−0.020	.....	4427.266			
Ti 33.3186	Standard	±0.000	.....	4443.976			
Ti 35.2474	4468.672	−0.009	.....	4468.663			
S 35.4537	4471.366	.....	−0.003	4471.676	−0.316	21.2	1
S 36.1905	4481.075	.....	+0.019	4481.400	−0.306	20.5	2
Ti 36.2164	4481.419	+0.019	.....	4481.438			
S 41.3134	4552.521	.....	+0.012	4552.750	−0.217	14.3	2
Ti 41.3201	4552.620	+0.012	.....	4552.632			
Ti 42.0857	4563.929	+0.010	.....	4563.939			
S 42.3338	4567.631	.....	+0.005	4567.950	−0.314	20.6	2
Ti 42.6353	Standard	±0.000	.....	4572.156			
S 42.7960	4574.579	.....	±0.000	4574.900	−0.311	20.4	1

Curvature Cor. +0.0005 mm. — Weighted mean −18.1 — Mean −18.5

V_a +20.77
V_d + 0.15
Reduction to Sun +20.92
Radial Velocity + 2.8 km.

ζ *CASSIOPEIAE* — A 355 — Measured by F. Power 12

Ti 28.9627	Standard	±0.000	.....	4338.084			
S 29.1747	4340.355	.....	0.000	4340.634	−0.279	−19.3	2
Ti 33.3655	4387.004	+0.003	.....	4387.007			
S 33.4441	4387.912	.....	−0.005	4388.100	−0.193	13.2	2
Ti 34.0764	4395.263	−0.062	.....	4395.201			
Ti 36.7481	4427.258	+0.008	.....	4427.266			
S 37.5660	4437.367	.....	+0.007	4437.718	−0.344	23.2	2
Ti 38.0936	4443.970	+0.006	.....	4443.976			
Ti 40.0224	Standard	±0.000	.....	4468.663			
S 40.2310	4471.387	.....	+0.018	4471.676	−0.271	18.2	2
S 40.9630	4481.032	.....	+0.083	4481.400	−0.285	19.1	1
Ti 40.9873	4481.355	+0.083	.....	4481.438			
S 46.0922	4552.570	.....	+0.024	4552.750	−0.156	10.3	1½
Ti 46.0968	4552.638	+0.024	.....	4552.662			
Ti 46.8620	4563.943	−0.004	.....	4563.939			
S 47.1174	4567.755	.....	−0.002	4567.950	−0.197	12.9	1
Ti 47.4106	Standard	±0.000	.....	4572.156			
S 47.5781	4574.682	.....	+0.002	4574.900	−0.216	14.2	½

Curvature Cor. +0.0010 mm. — Weighted mean −16.9 — Mean −16.3

V_a +20.77
V_d + 0.15
Reduction to Sun +20.19
Radial Velocity + 4.0 km.

SUMMARY OF MEASURES OF ζ *CASSIOPEIAE*

Plate	Date	Adams	No. of lines	Frost	No. of lines
A 281	1901, Oct. 31	.....	..	+0.8	11
B 211	Nov. 7	+3.5	7	.....	..
B 248	Nov. 27	+4.0	9	+2.4	8
A 355	1902, July 22	+2.8	7	+4.0	7
Mean		+3.3		+2.4	

Mean of 4 plates +2.7 km.
Mean of all measures +2.9 km.

3. ϵ *CASSIOPEIAE*

(R. A.= $1^h\ 47^m$; Dec.= $+63°\ 11'$; Mag. 3.6; Class IV *ab*)

Four plates of this star have been measured, all of which are common to the two observers. The spectrum contains but few lines, and these are very broad and difficult of measurement.

ϵ *CASSIOPEIAE*—A 261

1901, October 3, G. M. T. $17^h\ 15^m$ — Measured by A.
Hour angle E $1^h\ 35^m$ — Star fair; comparison good. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
t. m.	t. m.	t. m.	t. m.	t. m.	t. m.	km	
Ti 19.1034	Standard	±0.000	.....	4338.084			
S 19.3091	4340.273	.....	−0.001	4340.634	−0.362	−25.0	1
S 23.6055	4387.820	.....	−0.014	4388.100	−0.294	20.1	1
Ti 24.2459	4395.218	−0.017	.....	4395.201			
Ti 26.9383	Standard	±0.000	.....	4427.266			
S 27.7636	4437.410	.....	+0.009	4437.718	−0.299	20.2	1
Ti 28.2905	4443.962	+0.014	.....	4443.976			
Ti 30.2297	4468.645	+0.018	.....	4468.663			
S 30.4385	4471.357	.....	+0.016	4471.676	−0.303	20.3	1
S 31.1840	4481.125	.....	+0.011	4481.400	−0.264	17.7	1
Ti 32.7017	Standard	±0.000	.....	4501.445			

Curvature Cor. +0.0001mm. — Weighted mean −20.7 — Mean −20.7

V_a +13.49
V_d + 0.06
Reduction to Sun +13.55
Radial Velocity − 7.1 km.

ϵ *CASSIOPEIAE*—A 261

Measured by F.
Power 12

Ti 30.7668	Standard	±0.000	.....	4338.084			
S 30.9890	4340.452	.....	−0.002	4340.634	−0.184	−12.7	2
S 35.2729	4387.897	.....	−0.070	4388.100	−0.273	18.7	1
Ti 35.9119	4395.281	−0.080	.....	4395.201			
Ti 36.3172	4400.008	−0.073	.....	4399.935			
Ti 41.8970	4468.711	−0.048	.....	4468.663			
S 42.1104	4471.481	.....	−0.036	4471.676	−0.231	15.5	2
Ti 42.8707	Standard	±0.000	.....	4481.438			
S 42.8461	4481.114	.....	±0.000	4481.400	−0.286	19.1	2
Ti 48.7767	4563.920	+0.019	.....	4563.939			
Ti 49.3307	Standard	±0.000	.....	4572.156			

Curvature Cor. + 0.0003 mm. — Weighted mean −16.2 — Mean − 16.5

V_a +13.49
V_d + 0.06
Reduction to Sun +13.55
Radial Velocity − 2.6 km.

ε CASSIOPEIAE—A 275

1901, October 23, G. M. T. $20^h\ 35^m$ — Measured by A.
Hour angle W $3^h\ 5^m$ — Star rather weak; comparison good. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 24.5055	Standard	±0.000	.....	4338.084			
S 29.0245	4387.844	.....	±0.000	4388.100	−0.256	−17.5	2
Ti 30.0703	Standard	±0.000	.....	4399.935			
Ti 32.3639	4427.263	+0.003	.....	4427.266			
S 33.2000	4437.514	.....	+0.025	4437.718	−0.179	12.1	2
Ti 34.1426	4449.261	+0.052	.....	4449.313			
Ti 35.6617	4468.633	+0.030	.....	4468.663			
S 35.8816	4471.484	.....	+0.023	4471.676	−0.169	11.3	4
S 36.6239	4481.194	.....	±0.000	4481.400	−0.206	13.9	3
Ti 36.6424	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0002 mm. — Weighted mean −13.3 — Mean −13.7

V_a +7.65
V_d −0.11
Reduction to Sun + 7.54
Radical Velocity − 5.8 km.

ε CASSIOPEIAE—A 275

Measured by F.
Power 12

Ti 30.7013	Standard	±0.000	.....	4338.084			
S 30.9194	4340.398	.....	±0.000	4340.634	−0.236	−16.3	½
S 35.2210	4387.871	.....	+0.008	4388.100	−0.221	15.1	2
Ti 35.8565	4395.195	+0.009	.....	4395.201			
Ti 36.2644	Standard	±0.000	.....	4399.935			
Ti 41.8583	4468.647	+0.016	.....	4468.663			
S 42.0745	4471.448	.....	+0.012	4471.676	−0.216	14.5	2
S 42.8145	4481.122	.....	±0.000	4481.400	−0.278	18.6	2
Ti 42.8385	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0003 mm. — Weighted mean −16.0 — Mean −16.1

V_a +7.65
V_d −0.11
Reduction to Sun + 7.54
Radial Velocity − 8.5 km.

ε CASSIOPEIAE—A 278

1901, October 25, G. M. T. $14^h\ 8^m$ — Measured by A.
Hour angle E $3^h\ 35^m$ — Star good; comparison good. — Power 25

S 23.7063	4387.867	.....	−0.017	4388.100	−0.250	−17.1	1
Ti 24.3426	4395.218	−0.017	.....	4395.201			
Ti 24.7471	Standard	±0.000	.....	4399.935			
Ti 26.2616	4417.899	−0.015	.....	4417.884			
S 27.8617	4437.417	.....	−0.003	4437.718	−0.304	20.5	1
Ti 28.3891	Standard	±0.000	.....	4443.976			
Ti 30.3307	4468.678	−0.015	.....	4468.663			
S 30.5491	4471.513	.....	−0.012	4471.676	−0.175	11.7	3
S 31.2868	4481.174	.....	±0.000	4481.400	−0.226	15.1	4
Ti 31.3068	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0002 mm — Weighted mean −14.8 — Mean −16.1

V_a +7.09
V_d +0.12
Reduction to Sun + 7.21
Radial Velocity − 7.6 km.

ϵ *CASSIOPEIAE*—A 278

Measured by F.
Power 12

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 29.3007	Standard	±0.000	.....	4338.084			
S 29.5350	4340.574	.....	±0.000	4340.634	−0.060	− 4.1	1
Ti 33.7369	4387.004	+0.003	.....	4387.007			
S 33.8060	4387.797	.....	+0.003	4388.100	−0.300	20.5	2
Ti 34.8535	Standard	±0.000	.....	4389.935			
Ti 40.4379	4468.675	−0.012	.....	4468.663			
S 40.6615	4471.579	.....	−0.009	4471.676	−0.106	7.1	2
S 41.3959	4481.204	.....	±0.000	4481.400	−0.196	13.1	2
Ti 41.4136	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0003 mm.

Weighted Mean −12.2 Mean −11.2

V_a +7.09

V_d +0.12

Reduction to Sun + 7.21

Radial Velocity − 5.0 km.

ϵ *CASSIOPEIAE*—B 399

1902, August 27, G. M. T. $18^h\,49^m$
Hour angle E $2^h\,21^m$

Star good; comparison good.

Measured by A.
Power 15

Ti 20.8602	Standard	±0.000	.....	4338.084			
S 21.1412	4340.314	.....	+0.002	4340.634	−0.318	−22.0	1
S 26.8763	4387.657	.....	+0.044	4388.100	−0.399	27.3	1
Ti 27.7456	4395.150	+0.051	.....	4395.201			
Ti 28.2955	Standard	±0.000	.....	4399.935			
Ti 33.7409	4449.296	+0.017	.....	4449.313			
Ti 35.7701	4468.661	+0.002	.....	4468.663			
S 36.0427	4471.304	.....	+0.002	4471.676	−0.370	24.8	2
S 37.0402	4481.066	.....	±0.000	4481.400	−0.334	22.4	2
Ti 37.0779	Standard	±0.000	.....	4481.438			

Cuvature Cor. +0.0008 mm.

Weighted mean −23.9 Mean −24.1

V_a +19.50

V_d + 0.09

Reduction to Sun +19.59

Radial Velocity − 4.3 km.

ϵ *CASSIOPEIAE*—B 399

Measured by F.
Power 12

Ti 32.8406	Standard	±0.000	.....	4468.663			
S 33.1104	4471.282	.....	±0.000	4471.676	−0.394	−26.4	2
S 34.1070	4481.030	.....	±0.000	4481.400	−0.370	24.8	2
Ti 34.1485	Standard	±0.000	.....	4481.438			
Ti 34.8623	Standard	±0.000	.....	4488.493			

Curvature Cor. +0.0012 mm.

Weighted mean −25.6 Mean −25.6

V_a +19.50

V_d + 0.09

Reduction to Sun +19.59

Radial Velocity − 6.0 km.

SUMMARY OF MEASURES OF ϵ *CASSIOPEIAE*

Plate	Date	Adams	No. of Lines	Frost	No. of Lines
A 261	1901, Oct. 3	−7.1	5	−2.6	4
A 275	Oct. 23	−5.8	4	−8.5	4
A 278	Oct. 25	−7.6	4	−5.0	4
B 399	1902, Aug. 27	−4.3	4	−6.0	2
	Mean	−6.2		−5.5	

Mean of 4 plates −5.9 km.
Mean of all measures −5.9 km.

4. ζ *PERSEI*

(R. A. = 3h 48m; Dec. = +31°35′; Mag. 3.1; Class IIIa)

Five plates of this star have been measured, five by A., and two by F. The lines in this spectrum, though numerous, are extremely broad and ill defined, making accurate measurement difficult.

1901, September 12, G. M. T 18h 4m — ζ *PERSEI* — A 226 — Measured by A.
Hour angle E 4h 6m — Star rather weak; comparison fair. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
S 24.8256	4387.976	.....	+0.033	4388.100	−0.091	−6.2	1
He 24.8336	4388.067	+0.033	.....	4388.100			
Ti 25.4507	Standard	±0.000	.....	4395.201			
S 32.4118	4481.336	.....	−0.001	4481.400	−0.065	4.4	1
Ti 32.4196	4481.439	−0.001	.....	4481.438			
Ti 37.3098	Standard	±0.000	.....	4548.938			
Ti 38.3352	4563.915	+0.024	.....	4563.939			
S 38.6014	4567.852	.....	+0.018	4567.950	−0.080	5.2	3
Ti 38.8901	4572.146	+0.010	.....	4572.156			
S 39.0692	4574.822	.....	+0.010	4574.900	−0.068	4.5	1
Ti 41.8387	4617.445	+0.007	.....	4617.452			
S 43.9076	4650.888	.....	+0.002	4650.925	−0.035	2.3	1
S 44.5498	4661.564	.....	+0.001	4661.728	−0.163	10.5	1
Ti 44.9191	Standard	±0.000	.....	4667.768			
S 47.5475	4713.357	.....	−0.113	4713.308	−0.064	4.1	2
He 47.5511	4713.421	−0.113	.....	4713.308			

Curvature Cor. +0.0001 mm. — Weighted mean − 5.2 — Mean −5.3

V_a +27.45
V_d + 0.26

Reduction to Sun +27.72
Radial Velocity +22.5 km.

1901, September 18, G. M. T. 18h 26m — ζ *PERSEI* — A 235 — Measured by A
Hour angle E 3h 28m — Star good; comparison good. — Power 21

S 31.2357	4388.036	.....	±0.000	4388.100	−0.064	−4.4	1
Ti 31.8557	Standard	±0.000	.....	4396.201			
S 33.5371	4415.034	.....	−0.023	4415.076	−0.065	−4.4	3
S 33.7142	4417.157	.....	−0.025	4417.121	+0.011	+0.8	2
Ti 33.7768	4417.910	−0.026	.....	4417.884			
Ti 37.8433	Standard	±0.000	.....	4468.663			
S 38.0673	4471.571	.....	±0.000	4471.676	−0.105	−7.0	2
Ti 45.2786	Standard	±0.000	.....	4572.156			
S 45.4611	4574.890	.....	±0.000	4574.900	−0.010	−0.6	1

Curvature Cor. +0.0002 mm. — Weighted mean − 3.4 — Mean −3.1

V_a +26.38
V_d + 0.23

Reduction to Sun +26.61
Radial Velocity +23.2 km.

ζ *PERSEI* — B 218

1901, November 8, G. M. T. $16^h\,33^m$ — Measured by A.
Hour angle E $1^h\,55^m$ — Star fair; comparison fair. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 20.3486	Standard	±0.000	.....	4338.084			
S 20.7005	4340.868	.....	+0.002	4340.634	+0.236	+16.3	1
S 21.8100	4349.726	.....	+0.007	4349.541	+0.192	13.2	2
S 23.9597	4367.254	.....	+0.018	4367.012	+0.260	17.8	1
Ti 24.0282	4367.821	+0.018	.....	4367.839			
Ti 26.3119	4387.004	+0.003	.....	4387.007			
S 26.4615	4388.281	.....	+0.003	4388.100	+0.184	12.6	1
S 29.7918	4417.376	.....	±0.000	4417.121	+0.255	17.3	1
Ti 29.8487	Standard	±0.000	.....	4417.884			
Ti 35.3198	4468.676	−0.013	.....	4468.663			
S 35.6552	4471.917	.....	−0.013	4471.676	+0.228	15.3	3
Ti 36.6225	4481.450	−0.012	.....	4481.438			
Ti 43.5244	4552.612	+0.020	.....	4552.632			
S 43.5584	4552.981	.....	+0.020	4552.750	+0.251	16.5	2
Ti 44.5597	Standard	±0.000	.....	4563.939			
S 44.9421	4568.167	.....	±0.000	4567.950	+0.217	14.2	1

Curvature Cor. +0.0007 mm. — Weighted mean + 15.3 — Mean +15.4

V_a +7.57
V_d +0.14
Reduction to Sun + 7.71
Radial Velocity +23.0 km.

ζ *PERSEI* — B 218

Measured by F.
Power 12

Ti 29.5641	4338.015	+0.069	.....	4338.084			
S 29.8943	4340.634	.....	+0.075	4340.634	+0.075	+ 5.2	1
Ti 30.3631	4344.370	+0.081	.....	4344.451			
S 33.1907	4367.383	.....	+0.001	4367.012	+0.372	+25.5	1
Ti 33.2455	Standard	±0.000	.....	4367.839			
Ti 35.5309	4387.068	−0.061	.....	4387.007			
S 35.6642	4388.208	.....	−0.060	4388.100	+0.048	+ 3.3	½
Ti 37.0283	4399.982	−0.047	.....	4399.935			
S 38.7463	4415.114	.....	−0.055	4415.076	−0.017	− 1.2	½
Ti 39.0629	4417.940	−0.056	.....	4417.884			
Ti 44.2508	4466.012	−0.037	.....	4465.975			
Ti 44.8131	4471.429	−0.021	.....	4471.408			
S 44.8643	4471.925	.....	−0.020	4471.676	+0.229	+15.4	2
Ti 45.8403	Standard	±0.000	.....	4481.438			
Ti 52.7435	4552.588	+0.044	.....	4552.632			
S 52.7644	4552.814	.....	+0.043	4552.750	+0.107	+ 7.0	2
Ti 53.0235	4555.626	+0.036	.....	4555.662			
Ti 53.7800	4563.897	+0.042	.....	4563.939			
S 54.1745	4568.247	.....	+0.026	4567.950	+0.323	+21.2	2
Ti 54.5259	4572.143	+0.013	.....	4572.156			
S 54.8032	4575.231	.....	+0.011	4574.900	+0.343	+22.5	1
Ti 56.1242	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0013 mm. — Weighted Mean +14.2 — Mean +12.4

V_a +7.57
V_d +0.14
Reduction to Sun + 7.71
Radial Velocity +21.9 km.

ζ *PERSEI*—B 232

1901, November 14, G. M. T. $20^h\ 9^m$ — Measured by A.
Hour angle W $2^h\ 12^m$ — Star good; comparison good. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 20.4179	4387.005	+0.002	.....	4387.007			
S 20.5786	4388.380	.....	+0.002	4388.100	+0.282	+19.3	1
Ti 21.9154	Standard	±0.000	.....	4399.935			
Ti 23.1992	4411.225	+0.015	.....	4411.240			
S 23.6635	4415.355	.....	+0.014	4415.076	+0.293	19.9	1
S 23.8884	4417.365	.....	+0.014	4417.121	+0.258	17.5	1
Ti 29.4079	Standard	±0.000	.....	4468.663			
S 29.7458	4471.931	.....	±0.000	4471.676	+0.255	17.1	1
Ti 37.6141	4552.633	−0.001	.....	4552.632			
S 37.6446	4552.964	.....	−0.001	4552.750	+0.213	14.0	1
Ti 38.6481	Standard	±0.000	.....	4563.939			
S 39.0408	4568.278	.....	−0.022	4567.950	+0.306	20.1	1
Ti 39.3937	4572.199	−0.043	.....	4572.156			
S 39.6564	4575.131	.....	−0.043	4574.900	+0.188	12.3	1

Curvature Cor. +0.0008 mm. — Weighted mean +17.2 — Mean +17.2

V_a + 4.50
V_d − 0.16

Reduction to Sun + 4.34
Radial Velocity +21.5 km.

ζ *PERSEI*—B 232 — Measured by F. Power 12

Ti 29.6003	Standard	±0.000	.....	4338.084			
S 29.9374	4340.753	.....	−0.002	4340.634	+0.117	+ 8.1	1
Ti 30.0357	4341.533	−0.003	.....	4351.530			
Ti 33.2745	4367.813	+0.026	.....	4367.839			
Ti 35.5550	4386.997	+0.010	.....	4387.007			
S 35.7042	4388.272	.....	+0.010	4388.100	+0.182	12.4	2
Ti 37.5680	4404.420	+0.013	.....	4404.433			
S 38.7827	4415.164	.....	+0.003	4415.076	+0.091	6.2	1½
Ti 39.0870	Standard	±0.000	.....	4417.884			
Ti 44.2955	4465.952	+0.023	.....	4465.975			
Ti 44.8288	4471.393	+0.015	.....	4471.408			
S 44.8784	4471.874	.....	+0.014	4471.676	+0.222	14.8	2
Ti 45.8569	Standard	±0.000	.....	4481.438			
Ti 52.7516	Standard	±0.000	.....	4552.632			
S 52.7963	4553.117	.....	±0.000	4552.750	+0.367	24.2	.1
Ti 53.7863	4563.933	+0.006	.....	4563.939			
S 54.1777	4568.246	.....	−0.006	4567.950	+0.307	20.2	1½
Ti 54.5307	4572.171	−0.015	.....	4572.156			
S 54.7863	4575.019	.....	−0.013	4574.900	+0.100	6.9	1
Ti 56.1281	4590.151	−0.025	.....	4590.126			
Ti 59.4987	Standard	±0.000	.....	4629.521			
S 59.6276	4631.067	.....	±0.000	4630.703	+0.364	23.6	1
S 60.5525	4642.246	.....	±0.000	4641.886	+0.360	23.3	1
Ti 60.8086	4645.369	−0.001	.....	4645.368			
Ti 61.7253	4656.651	−0.007	.....	4656.644			
S 62.1632	4662.096	.....	−0.018	4661.728	+0.350	22.5	1
Ti 62.6184	4667.796	−0.028	.....	4667.768			
Ti 65.9195	Standard	±0.000	.....	4710.471			
S 66.1666	4713.646	.....	+0.002	4713.308	+0.340	21.6	1

Curvature Cor. + 0.0013 mm. — Weighted mean +16.0 — Mean +16.6

V_a + 4.50
V_d − 0.16

Reduction to Sun + 4.34
Radial Velocity +20.3 km.

ζ *PERSEI*—B 424

1902, October 15, G. M. T. 16h 43m — Measured by A.
Hour angle E 3h 25m — Star good; comparison good. — Power 17

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 22.2046	Standard	±0.000	.....	4338.084			
S 22.5242	4340.628	.....	−0.002	4340.634	−0.008	− 0.6	1
S 23.1684	4345.787	.....	−0.006	4345.677	+0.104	+ 7.2	2
S 25.7668	4367.033	.....	−0.023	4367.012	−0.002	− 0.1	1
Ti 29.0872	4395.246	−0.045	.....	4395.201			
Ti 29.6321	4399.994	−0.059	.....	4399.935			
S 31.3521	4415.211	.....	−0.057	4415.076	+0.078	+ 5.3	2
S 31.5819	4417.271	.....	−0.057	4417.121	+0.093	+ 6.3	1
Ti 31.6566	4417.941	−0.057	.....	4417.884			
Ti 37.0948	Standard	±0.000	.....	4468.663			
S 37.4102	4471.723	.....	−0.001	4471.676	+0.046	+ 3.1	1
Ti 38.4027	4481.441	−0.003	.....	4481.438			
S 38.4103	4481.516	.....	−0.003	4481.400	+0.113	+ 7.6	1
Ti 45.2667	4552.561	+0.071	.....	4552.632			
S 45.2827	4552.735	.....	+0.071	4552.750	+0.056	+ 3.7	3
Ti 46.2989	4563.886	+0.053	.....	4563.939			
S 46.6572	4567.858	.....	+0.056	4567.950	−0.036	− 2.4	2
Ti 47.0375	4572.097	+0.059	.....	4572.156			
S 47.2942	4574.972	.....	+0.055	4574.900	+0.127	+ 8.3	1
Ti 50.9749	Standard	±0.000	.....	4617.452			

Curvature Cor. +0.0009 mm.

Weighted mean + 3.8 — Mean + 3.8

V_a +18.40
V_d + 0.23
Reduction to Sun +18.63
Radial Velocity +22.4 km.

SUMMARY OF MEASURES OF ζ *PERSEI*.

Plate	Date	Adams	No. of Lines	Frost	No. of Lines
A 226	1901, Sept. 12	+22.5	7	.....	..
A 235	Sept. 18	+23.2	5	.....	..
B 218	Nov. 8	+23.0	8	+21.9	8
B 232	Nov. 14	+21.5	7	+20.3	11
B 424	1902, Oct. 15	+22.4	10	.....	..
Mean		+22.5		+21.1	

Mean of 5 plates +22.3 km.
Mean of all measures +22.1 km.

6. β *ORIONIS*.

(R. A. = 5h 10m; Dec. = −8° 19′; Mag. 0.3; Class VIc)

Especial attention has been given to the investigation of this well-known star because of the Potsdam observations of 1890, which seemed to indicate a variation in its radial velocity. A total of nineteen plates extending over an interval of six months have been measured, five by F., and nineteen by A. The results do not indicate any variation of velocity. The spectrum of this star is characterized by the strength of its *Orion* lines and the existence of several faint metallic lines. The breadth of these lines is the chief difficulty in the way of accurate measurement.

β ORIONIS—A 207

1901, September 4, G. M. T. $21^h\ 43^m$ — Measured by A. with Zeiss Comparator
Hour angle E $2^h\ 29^m$ — Star strong; comparison good. — Power 18

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 62.4073	Standard	±0.000	.....	4338.084			
S 62.1758	4340.544	.....	±0.000	4340.634	−0.090	−6.2	1
S 57.8843	4387.998	.....	−0.005	4388.100	−0.107	7.3	1
Ti 57.2599	4395.207	−0.006	.....	4395.201			
Ti 56.8542	Standard	±0.000	.....	4399.935			
Ti 52.1340	4457.600	±0.000	.....	4457.600			
Ti 51.2739	4468.665	−0.002	.....	4468.663			
S 51.0433	4471.662	.....	−0.002	4471.676	−0.016	1.1	1
S 50.3072	4481.319	.....	±0.000	4481.400	−0.081	5.4	1
Ti 50.2982	Standard	±0.000	.....	4481.438			

Curvature Cor. −0.0002 mm. — Weighted mean − 5.0 — Mean −5.0

V_a +25.24
V_d + 0.20
Reduction to Sun +25.44
Radial Velocity +20.4 km.

β ORIONIS—A 262

1901, October 3, G. M. T. $19^h\ 26^m$ — Measured by A.
Hour angle E $2^h\ 49^m$ — Star good; comparison good. — Power 21

Ti 19.2059	Standard	±0.000	.....	4338.084			
S 23.7369	4388.179	.....	−0.046	4388.100	+0.033	+2.2	1
Ti 24.7553	4399.992	−0.057	.....	4399.935			
S 27.8874	4437.700	.....	−0.005	4437.718	−0.023	−1.6	1
Ti 28.3915	4443.972	+0.004	.....	4443.976			
Ti 28.8172	Standard	±0.000	.....	4449.313			
Ti 30.3324	4468.668	−0.005	.....	4468.663			
S 30.5638	4471.672	.....	−0.001	4471.676	−0.005	−0.3	1
S 31.3043	4481.374	.....	+0.014	4481.400	−0.012	−0.8	1
Ti 31.3081	4481.424	+0.014	.....	4481.438			
Ti 37.2144	Standard	±0.000	.....	4563.939			
S 37.4833	4567.928	.....	±0.000	4567.950	−0.022	−1.4	1

Curvature Cor. +0.0001 mm. — Weighted mean − 0.4 — Mean −0.4

V_a +22.92
V_d + 0.23
Reduction to Sun +23.15
Radial Velocity +22.8 km.

β ORIONIS—B 207

1901, October 18, G. M. T. $20^h\ 7^m$ — Measured by A.
Hour angle E $1^h\ 12^m$ — Star good; comparison good. — Power 24

Ti 22.9731	Standard	±0.000	.....	4338.084			
S 23.3055	4340.709	.....	−0.001	4340.634	+0.074	+5.1	2
S 29.0872	4388.203	.....	−0.019	4388.100	+0.084	5.7	1
Ti 29.9062	4395.223	−0.022	.....	4395.201			
S 34.6936	4437.824	.....	−0.003	4437.718	+0.103	7.0	1
Ti 35.3601	Standard	±0.000	.....	4443.976			
Ti 37.9741	4468.654	+0.009	.....	4468.663			
S 38.2864	4471.663	.....	+0.017	4471.676	+0.004	0.3	3
S 39.2846	4481.367	.....	+0.045	4481.400	+0.012	0.8	4
Ti 39.2873	4481.393	+0.045	.....	4481.438			
Ti 45.8676	Standard	±0.000	.....	4548.938			
Ti 46.2087	4552.618	+0.014	.....	4552.632			
S 46.2208	4552.749	.....	+0.014	4552.750	+0.013	0.9	1

Curvature Cor. +0.0002 mm. — Weighted mean + 2.3 — Mean +3.3

V_a +19.38
V_d + 0.10
Reduction to Sun +19.48
Radial Velocity +21.8 km.

β ORIONIS—B 207

Measured by F.
Power 17

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 19.675	Standard	±0.000	.....	4338.084			
S 19.994	4340.604	.....	−0.003	4340.634	−0.033	−2.3	1
Ti 25.656	4387.079	−0.072	.....	4387.007			
S 25.777	4388.105	.....	−0.070	4388.100	−0.065	−4.4	1
Ti 30.239	4427.276	−0.010	.....	4427.266			
Ti 34.680	Standard	±0.000	.....	4468.663			
S 34.996	4471.705	.....	+0.008	4471.676	+0.037	+2.5	2
S 35.984	4481.303	.....	+0.035	4481.400	−0.062	−4.2	3
Ti 35.994	4481.403	+0.035	.....	4481.438			
Ti 43.959	4563.906	+0.033	.....	4563.939			
S 44.327	4567.954	.....	+0.029	4567.950	+0.033	+2.2	2
Ti 46.308	Standard	±0.000	.....	4590.126			

Weighted mean −1.1 Mean −1.2
Curvature Cor. −0.17
V_a +19.38
V_d + 0.10
Reduction to Sun +19.48
Radial Velocity +18.2 km.

β ORIONIS—A 284

1901, October 31, G. M. T. 19h 58m
Hour angle E 0h 29m
Star good; comparison good.
Measured by A.
Power 21

S 23.5148	4340.641	.....	±0.000	4340.634	+0.007	+0.5	2
Ti 23.5983	Standard	±0.000	.....	4341.530			
Ti 27.7147	4387.009	−0.002	.....	4387.007			
S 27.8156	4388.166	.....	−0.002	4388.100	+0.064	4.7	3
Ti 29.2155	Standard	±0.000	.....	4404.433			
Ti 34.2076	4465.956	+0.019	.....	4465.975			
S 34.6563	4471.772	.....	+0.012	4476.676	+0.108	7.2	3
S 35.3907	4481.400	.....	±0.000	4481.400	±0.000	0.0	3
Ti 35.3936	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0005 mm.
Weighted mean + 3.2 Mean +3.0
V_a +15.23
V_d + 0.04
Reduction to Sun +15.27
Radial Velocity +18.5 km.

β ORIONIS — B 213

1901, November 7, G. M. T., 18h 6m
Hour angle E 1h 50m
Star good; comparison fair.
Measured by A.
Power 21

S 33.3753	4388.314	.....	±0.000	4388.100	+0.214	+14.6	1
Ti 34.7200	Standard	±0.000	.....	4389.935			
Ti 42.2191	4468.689	−0.026	.....	4468.663			
S 42.5474	4471.862	.....	−0.020	4471.676	+0.166	11.1	1
Ti 43.5294	Standard	±0.000	.....	4481.438			
S 43.5355	4481.498	.....	±0.000	4481.400	+0.098	6.6	2
Ti 53.8091	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0008 mm.
Weighted mean + 9.7 Mean +10.8
V_a +12.67
V_d + 0.16
Reduction to Sun +12.83
Radial Velocity +22.5 km.

β ORIONIS—B 220

1901, November 8, G. M. T. $20^h\ 6^m$ — Measured by A.
Hour angle W $0^h\ 10^m$ — Star good; comparison slightly weak. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m	t. m.	km.	
Ti 20.1587	Standard	±0.000	.....	4338.084			
S 20.4953	4340.749	.....	−0.001	4340.634	+0.114	+7.9	2
S 21.9256	4352.202	.....	−0.005	4352.083	+0.114	7.9	2
S 26.2738	4388.332	.....	−0.018	4388.100	+0.214	14.6	1
Ti 27.0757	4395.221	−0.020	.....	4395.201			
Ti 32.5195	Standard	±0.000	.....	4443.976			
Ti 35.1300	4468.661	+0.002	.....	4468.663			
S 35.4584	4471.830	.....	+0.004	4471.676	+0.158	10.6	2
Ti 36.4438	4481.427	+0.011	.....	4481.438			
S 36.4585	4481.587	.....	+0.011	4481.400	+0.198	13.2	3
Ti 45.1340	Standard	±0.000	.....	4572.156			
S 46.2063	4584.173	.....	±0.000	4584.018	+0.155	10.1	1

Curvature Cor. +0.0009 mm. — Weighted mean +10.7 — Mean +10.7

V_a +12.25
V_d − 0.01

Reduction to Sun +12.24
Radial Velocity +22.9 km.

β ORIONIS—B 231

1901, November 14, G. M. T. $19^h\ 19^m$ — Measured by A.
Hour angle E $0^h\ 15^m$ — Star good; comparison good. — Power 21

Ti 18.6998	Standard	±0.000	.....	4338.084			
S 19.0460	4340.831	.....	−0.003	4340.634	+0.194	+13.4	1
Ti 24.6539	4387.055	−0.048	.....	4387.007			
S 24.7978	4388.286	.....	−0.047	4388.100	+0.139	9.5	1
Ti 33.6420	4468.662	+0.001	.....	4468.663			
S 33.9775	4471.906	.....	+0.001	4471.676	+0.231	15.5	1
Ti 34.9543	Standard	±0.000	.....	4481.438			
S 34.9709	4481.601	.....	±0.000	4481.400	+0.201	13.4	3
S 44.7033	4584.259	.....	±0.000	4584.018	+0.241	15.8	1
Ti 45.2195	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0008 mm. — Weighted mean +13.5 — Mean +13.5

V_a + 9.85
V_d + 0.02

Reduction to Sun + 9.87
Radial Velocity +23.4 km.

β ORIONIS—B 237

1901, November 15, G. M. T. $18^h\ 52^m$ — Measured by A.
Hour angle E $0^h\ 35^m$ — Star good; comparison good. — Power 21

Ti 20.7414	Standard	±0.000	.....	4338.084			
S 21.0810	4340.777	.....	−0.002	4340.634	+0.141	+9.7	1
Ti 26.6980	4387.049	−0.042	.....	4387.007			
S 26.8506	4388.354	.....	−0.041	4388.100	+0.213	14.5	2
Ti 34.3108	Standard	±0.000	.....	4455.485			
Ti 35.6896	4468.656	+0.007	.....	4468.663			
S 36.0229	4471.878	.....	+0.012	4471.676	+0.214	14.4	3
Ti 37.0002	4481.412	+0.026	.....	4481.438			
S 37.0130	4481.538	.....	+0.026	4481.400	+0.164	11.0	4
S 46.7429	4584.143	.....	+0.001	4584.018	+0.126	8.2	1
Ti 47.2694	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0008 mm. — Weighted mean +12.2 — Mean +11.6

V_a +9.44
V_d +0.05

Reduction to Sun + 9.49
Radial Velocity +21.7 km.

β ORIONIS—B 252

1901, November 27, G. M. T. $21^h\,22^m$ — Measured by A.
Hour angle W $2^h\,43^m$ — Star good; comparison good. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 18.1164	Standard	±0.000	.....	4338.084			
S 18.4616	4340.849	.....	−0.004	4340.634	+0.211	+14.6	1
Ti 24.0166	4387.076	−0.069	.....	4387.007			
S 24.1593	4388.308	.....	−0.068	4388.100	+0.140	9.6	1
Ti 32.9216	Standard	±0.000	.....	4468.663			
S 33.2595	4471.959	.....	+0.003	4471.676	+0.286	19.2	2
Ti 34.2210	4481.424	+0.014	.....	4481.438			
S 34.2413	4481.625	.....	+0.014	4481.400	+0.239	16.0	3
Ti 44.4023	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0009 mm. — Weighted mean +15.8 — Mean +14.8

V_a +4.23
V_d −0.22
Reduction to Sun + 4.01
Radial Velocity +19.8 km.

β ORIONIS—B 257

1901, December 18, G. M. T. $18^h\,12^m$ — Measured by A.
Hour angle W $0^h\,56^m$ — Star good; comparison good. — Power 21

Ti 17.0931	Standard	±0.000	.....	4338.084			
S 17.4562	4341.007	.....	−0.002	4340.634	+0.371	+25.6	1
Ti 22.9621	4387.039	−0.032	.....	4387.007			
S 23.1360	4388.547	.....	−0.032	4388.100	+0.415	28.4	2
Ti 31.4164	Standard	±0.000	.....	4464.617			
S 32.1790	4472.068	.....	+0.032	4471.676	+0.424	28.4	3
Ti 33.1190	4481.363	+0.075	.....	4481.438			
S 33.1516	4481.687	.....	+0.075	4481.400	+0.362	24.2	2
S 42.7593	4584.341	.....	±0.000	4584.018	+0.323	21.1	1
Ti 43.2620	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0007 mm. — Weighted mean +26.3 — Mean +25.6

V_a −5.14
V_d −0.08
Reduction to Sun − 5.22
Radial Velocity +21.1 km.

β ORIONIS—A 297

1901, December 19, G. M. T. $17^h\,34^m$ — Measured by A.
Hour angle W $0^h\,23^m$ — Star good; comparison good. — Power 21

Ti 21.0390	Standard	±0.000	.....	4338.084			
S 21.3084	4341.000	.....	−0.002	4340.634	+0.364	+25.2	1
Ti 25.4010	4387.040	−0.033	.....	4387.007			
S 25.5270	4388.511	.....	−0.029	4388.100	+0.382	26.1	2
Ti 26.4958	Standard	±0.000	.....	4399.935			
Ti 31.9849	4468.652	+0.011	.....	4468.663			
S 32.2453	4472.091	.....	+0.008	4471.676	+0.423	28.4	2
Ti 32.9465	Standard	±0.000	.....	4481.438			
S 32.9680	4481.726	.....	±0.000	4481.400	+0.326	21.8	2

Curvature Cor. +0.0006 mm. — Weighted mean +25.4 — Mean +25.4

V_a −5.58
V_d −0.03
Reduction to Sun − 5.61
Radial Velocity +19.8 km.

β ORIONIS—B 261

1901, December 31, G. M. T. $15^h\ 12^m$ — Measured by A.
Hour angle E $1^h\ 12^m$ — Star good; comparison good. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
S 23.8840	4341.118	.....	±0.000	4340.634	+0.484	+33.4	2
Ti 23.9354	Standard	±0.000	.....	4341.530			
Ti 29.4018	4387.014	−0.007	.....	4387.007			
S 29.5832	4388.581	.....	−0.006	4388.100	+0.475	32.5	1
Ti 31.3940	Standard	±0.000	.....	4404.433			
Ti 37.8867	4464.638	−0.021	.....	4464.617			
S 38.6513	4472.097	.....	−0.012	4471.676	+0.409	27.4	3
Ti 39.5972	Standard	±0.000	.....	4481.438			
S 39.6438	4481.901	.....	±0.000	4481.400	+0.501	33.5	4

Curvature Cor. +0.0008 mm. — Weighted mean +31.6 — Mean +31.7

V_a −10.69
V_d + 0.10

Reduction to Sun −10.59
Radial Velocity +21.0 km.

β ORIONIS—B 261 — Measured by F. Power 12

S 29.9627	4341.268	.....	+0.001	4340.634	+0.635	+43.9	1
Ti 30.3581	Standard	±0.000	.....	4344.451			
Ti 35.4653	4387.066	−0.059	.....	4387.007			
S 35.6385	4388.562	.....	−0.059	4388.100	+0.403	27.5	1
Ti 39.9853	Standard	±0.000	.....	4427.266			
Ti 44.0680	4465.969	+0.006	.....	4465.975			
S 44.7186	4472.117	.....	+0.003	4471.676	+0.444	29.8	3
Ti 45.6641	Standard	±0.000	.....	4481.438			
S 45.7128	4481.921	.....	±0.000	4481.400	+0.521	34.9	3

Weighted mean +33.2 — Mean +34.0
Curvature Cor. − 0.82

V_a −10.69
V_d + 0.10

Reduction to Sun −10.59
Radial Velocity +21.8 km.

β ORIONIS—A 300

1902, January 4, G. M. T. $17^h\ 44^m$ — Measured by A.
Hour angle W $1^h\ 35^m$ — Star strong; comparison good. — Power 21

Ti 22.4561	Standard	±0.000	.....	4338.084			
S 22.7409	4341.162	.....	−0.003	4340.634	+0.525	+36.3	1
Ti 26.8268	4387.053	−0.046	.....	4387.007			
S 26.9671	4388.688	.....	−0.043	4388.100	+0.545	37.2	2
Ti 28.8668	Standard	±0.000	.....	4411.240			
Ti 33.4260	4468.678	−0.015	.....	4468.663			
S 33.6985	4472.269	.....	−0.011	4471.676	+0.582	39.0	2
Ti 34.3880	Standard	±0.000	.....	4481.438			
S 34.4196	4481.861	.....	±0.000	4481.400	+0.461	30.8	3

Curvature Cor. +0.0005 mm. — Weighted mean +35.2 — Mean +35.8

V_a −12.35
V_d − 0.14

Reduction to Sun −12.49
Radial Velocity +22.7 km.

β ORIONIS A 306

1902, January 8, G. M. T. $18^h\ 15^m$ — Star good; comparison good. — Measured by A.
Hour angle W $2^h\ 24^m$ — Power 20

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 26.0198	Standard	±0.000	.....	4338.084			
S 26.3109	4341.220	.....	±0.000	4340.634	+0.586	+40.5	1
S 30.5367	4388.582	.....	±0.000	4388.100	+0.482	32.9	1
Ti 31.5042	Standard	±0.000	.....	4399.935			
Ti 37.0198	4468.652	+0.011	.....	4468.663			
S 37.2933	4472.248	.....	+0.008	4471.676	+0.580	38.9	2
Ti 37.9859	Standard	±0.000	.....	4481.438			
S 38.0223	4481.924	.....	±0.000	4481.400	+0.524	35.1	1

Curvature Cor. +0.0005 mm. — Weighted mean +37.2 — Mean +36.8

V_a −13.92
V_d − 0.20

Reduction to Sun −14.12
Radial Velocity +23.1 km.

β ORIONIS—B 270

1902, January 9, G. M. T. $14^h\ 41^m$ — Star good; comparison good. — Measured by A.
Hour angle E $1^h\ 14^m$ — Power 21

Ti 18.3004	Standard	±0.000	.....	4338.084			
S 24.3850	4388.587	.....	±0 000	4388.100	+0.487	+33.3	1
Ti 25.6876	Standard	±0.000	.....	4399.935			
Ti 33.1168	4468.654	+0.009	.....	4468.663			
S 33.4863	4472.261	.....	+0.007	4471.676	+0.592	39.7	1
Ti 34.4178	Standard	±0.000	.....	4481.438			
S 34.4691	4481.947	.....	±0.000	4481.400	+0.547	36.5	2
Ti 44.6069	Standard	±0.000	.....	4590.126			
Ti 50.1609	Standard	±0.000	.....	4656.644			
Ti 54.3252	Standard	±0.000	.....	4710.368			
S 54.5924	4713.937	.....	±0.000	4713.308	+0.629	40.0	1

Curvature Cor. +0.0008 mm. — Weighted mean +37.2 — Mean +37.4

V_a − 14.24
V_d + 0.11

Reduction to Sun −14.13
Radial Velocity +23.1 km.

β ORIONIS—B 270

Measured by F.
Power 13

S 29.9906	4341.124	.....	−0.001	4340.634	+0.489	+33.8	2
Ti 30.0412	Standard	±0.000	.....	4341.530			
Ti 35.5109	4387.073	−0.067	.....	4387.007			
S 35.7116	4388.806	.....	−0.069	4388.100	+0.637	43.5	2
Ti 44.1458	4465.986	−0.011	.....	4465.975			
Ti 44.7062	4471.435	−0.027	.....	4471.408			
S 44.7878	4472.231	.....	−0.013	4471.676	+0.542	36.3	3
Ti 45.7239	Standard	±0.000	.....	4481.438			
S 45.7722	4481.917	.....	±0.000	4481.400	+0.517	34.6	3
Ti 63.4749	Standard	±0.000	.....	4682.088			
Ti 65.6312	4710.406	−0.038	.....	4710.368			
S 65.8922	4713.901	.....	−0.038	4713.308	+0.555	35.3	1

Weighted mean +36.5 — Mean +36.7
Curvature Cor. − 0.82

V_a −14.24
V_d + 0.11

Reduction to Sun −14.13
Radial Velocity +21.6 km.

1902, January 16, G. M. T. $17^h\ 3^m$ — *β ORIONIS*—B 277 — Measured by A.
Hour angle W $1^h\ 46^m$ — Star good; comparison good. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 17.2623	Standard	±0.000	.....	4338.084			
S 17.6427	4341.132	.....	−0.002	4340.634	+0.496	+34.3	1
Ti 23.1558	4387.042	−0.035	.....	4387.007			
Ti 24.6347	Standard	±0.000	.....	4399.935			
S 28.8554	4438.179	.....	+0.046	4437.718	+0.507	34.3	1
Ti 29.4687	4443.923	+0.053	.....	4443.976			
Ti 32.0516	4468.657	+0.006	.....	4468.663			
S 32.4205	4472.263	.....	+0.004	4471.676	+0.591	39.6	3
Ti 33.3503	Standard	±0.000	.....	4481.438			
S 33.3924	4481.856	.....	±0.000	4481.400	+0.456	30.5	2
S 43.0322	4584.478	.....	±0.000	4584.018	+0.460	30.1	1
Ti 43.5254	Standard	±0.000	.....	4590.126			
Ti 49.0727	Standard	±0.000	.....	4656.644			
Ti 53.2285	Standard	±0.000	.....	4710.368			
S 53.4933	4713·913	.....	±0.000	4713.308	+0.605	38.5	2

Curvature Cor. +0.0008 mm. — Weighted mean +35.6 — Mean +34.5

V_a −16.81
V_d − 0.15

Reduction to Sun −16.96
Radial Velocity +18.6 km.

β ORIONIS—B 277 — Measured by F. with Zeiss Comparator
Power 17

S 24.4155	4341.181	.....	±0.000	4340.634	+0.547	+37.8	2
Ti 24.4587	Standard	±0.000	.....	4341.530			
Ti 29.8992	4387.055	−0.048	.....	4387.007			
S 30.0715	4388.550	.....	−0.048	4388.100	+0.402	27.5	3
Ti 38.4880	Standard	±0.000	.....	4465.975			
Ti 39.0440	4471.412	−0.004	.....	4471.408			
S 39.1255	4472.213	.....	−0.004	4471.676	+0.533	35.7	2
Ti 40.0540	4481.398	+0.040	.....	4481.438			
S 40.0952	4481.808	.....	+0.040	4481.400	+0.448	30.0	4
Ti 44.1042	4522.918	+0.058	.....	4522.974			
S 44.1345	4523.237	.....	+0.058	4522.802	+0.493	32.7	1
S 49.7010	4584.492	.....	+0.005	4584.018	+0.479	31.3	½
Ti 50.1905	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0011 mm. — Weighted mean +31.82 — Mean +32.5

V_a −16.81
V_d −. 0.15

Reduction to Sun −16.96
Radial Velocity +14.9 km.

1902, January 24, G. M. T. $12^h\ 50^m$ — *β ORIONIS*—B 282 — Measured by F. with Zeiss Comparator
Hour angle E $2^h\ 00^m$ — Star good; comparison good. — Power 13

Ti 32.207	Standard	±0.000	.....	4338.084			
S 32.586	4341.132	.....	±0.001	4340.634	+0.497	+34.3	1
Ti 38.076	4387.024	−0.017	.....	4387.007			
S 38.257	4388.594	.....	−0.017	4388.100	+0.477	32.6	1
Ti 39.551	Standard	±0.000	.....	4399.935			
Ti 46.937	4468.665	−0.002	.....	4468.663			
S 47.309	4472.318	.....	−0.002	4471.676	+0.640	42.9	1
Ti 48.229	Standard	±0.000	.....	4481.438			
S 48.288	4482.026	.....	±0.000	4481.400	+0.626	41.9	2

Curvature Cor. +0.0011 mm. — Weighted mean +38.7 — Mean +37.9

V_a −19.32
V_d + 0.17

Reduction to Sun −19.15
Radial Velocity +19.6 km.

β ORIONIS—B 282

Measured by A. Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 23.2788	Standard	±0.000	.....	4338.084			
S 23.6556	4341.106	.....	±0.000	4340.634	+0.472	+32.6	2
S 29.3646	4388.745	.....	±0.000	4388.100	+0.645	44.1	2
Ti 30.1065	Standard	±0.000	.....	4395.201			
Ti 31.9213	4411.266	−0.026	.....	4411.240			
S 32.6320	4417.665	.....	−0.023	4417.121	+0.521	35.4	1
Ti 38.0620	Standard	±0.000	.....	4468.663			
S 38.4323	4472.283	.....	±0.000	4471.676	+0.607	40.7	3
Ti 39.3653	4481.488	−0.050	.....	4481.438			
S 39.4324	4482.028	.....	−0.050	4481.400	+0.578	38.7	1
Ti 55.0843	Standard	±0.000	.....	4656.644			
Ti 57.0867	Standard	±0.000	.....	4682.088			
Ti 58.3815	Standard	±0.000	.....	4698.946			
S 59.5088	4713.891	.....	±0.000	4713.308	+0.583	37.1	3

Curvature Cor. +0.0008 mm. Weighted mean +38.4 Mean +38.1

V_a −19.32
V_d + 0.17

Reduction to Sun −19.15
Radial Velocity +19.2 km.

β ORIONIS—A 312

1902, February 10, G. M. T. 14h 54m
Hour angle, W 1h 10m

Star good; comparison good.

Measured by A. Power 21

Ti 25.3630	Standard	±0.000	.....	4338.084			
S 25.6543	4341.234	.....	−0.001	4340.634	+0.599	+41.4	2
Ti 29.7287	4387.019	−0.012	.....	4387.007			
S 29.8806	4388.791	.....	−0.011	4388.100	+0.680	46.4	1
Ti 31.7702	Standard	±0.000	.....	4411.240			
S 33.9747	4438.429	.....	+0.007	4437.718	+0.718	48.5	1
Ti 34.4129	4443.967	+0.009	.....	4443.976			
Ti 36.3238	4468.657	+0.006	.....	4468.663			
S 36.6081	4472.407	.....	+0.004	4471.676	+0.735	49.3	3
Ti 37.2864	Standard	±0.000	.....	4481.438			
S 37.3279	4481.994	.....	±0.000	4481.400	+0.594	39.7	3

Curvature Cor. +0.0005 mm. Weighted mean +44.5 Mean +45.1

V_a −23.47
V_d − 0.10

Reduction to Sun −23.57
Radial Velocity +20.9 km.

β ORIONIS—A330

1902, March 3, G. M. T. 13h 44m
Hour angle W 1h 23m

Star good; comparison good.

Measured by A. Power 21

Ti 22.3238	Standard	±0.000	.....	4338.084			
S 22.6222	4341.307	.....	±0.000	4340.634	+0.673	+46.5	2
Ti 26.6919	4386.978	+0.029	.....	4387.007			
S 26.8362	4388.658	.....	+0.027	4388.100	+0.585	40.0	2
Ti 27.7949	Standard	±0.000	.....	4399.935			
Ti 33.2998	4468.672	−0.009	.....	4468.663			
S 33.5810	4472.377	.....	−0.006	4471.676	+0.695	46.6	4
Ti 34.2624	Standard	±0.000	.....	4481.438			
S 34.3070	4482.035	.....	±0.000	4481.400	+0.635	42.5	3

Curvature Cor. +0.0005 mm. Weighted mean +44.3 Mean +43.9

V_a −25.63
V_d − 0.12

Reduction to Sun −25.75
Radial Velocity +18.5 km.

SUMMARY OF MEASURES OF β *ORIONIS*

Plate	Date	Adams	No. of Lines	Frost	No. of Lines
A207	1901, Sept. 4	+20.4	4	.....	..
A262	Oct. 3	+22.8	5	.....	..
B207	Oct. 18	+21.8	6	+18.2	5
A284	Oct. 31	+18.5	4	.....	..
B213	Nov. 7	+22.5	3	.....	..
B220	Nov. 8	+22.9	6	.....	..
B231	Nov. 14	+23.4	5	.....	..
B237	Nov. 15	+21.7	5	.....	..
B252	Nov. 27	+19.8	4	.....	..
B257	Dec. 18	+21.1	5	.....	..
A297	Dec. 19	+19.8	4	.....	..
B261	Dec. 31	+21.0	4	+21.8	4
A300	1902, Jan. 4	+22.7	4	.....	..
A306	Jan. 8	+23.1	4	.....	..
B270	Jan. 9	+23.1	4	+21.6	5
B277	Jan. 16	+18.6	6	+14.9	5
B282	Jan. 24	+19.2	6	+19.6	4
A312	Feb. 10	+20.9	5	.....	..
A330	Mar. 3	+18.5	4	.....	..
	Mean	+21.1		+19.2	

Mean of 19 plates +20.9 km.
Mean of all measures +20.7 km.

7. γ *ORIONIS*

(R. A.=5^h 20^m; Dec.=+6° 15′; Mag. 1. 9; Class IVa)

Seven plates of this star have been measured, six by A., and four by F., with three common to the two observers. An interesting systematic difference seems to exist in the two sets of measures, which is probably due to the different personality effects which enter into the settings upon the broad lines of the star spectrum. The general features of this spectrum are very similar to those of ζ *Persei*.

1901, September 11, G. M. T. 21^h 32^m — γ *ORIONIS* — A224 — Measured by A.
Hour angle E 2^h 17^m — Star fair; comparison rather weak. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
S 26.0285	4340.459	.....	±0.000	4340.634	−0.175	−12.1	4
H 26.0449	Standard	±0.000	.....	4340.634			
S 30.3242	4387.938	.....	−0.056	4388.100	−0.218	14.9	2
Ti 30.9596	4395.266	−0.065	.....	4395.201			
Ti 36.9536	Standard	±0.000	.....	4468.663			
S 37.1664	4471.419	.....	+0.028	4471.676	−0.229	15.4	2
He 37.1849	4471.648	+0.028	.....	4471.676			
S 37.9127	4481.174	.....	+0.027	4481.400	−0.199	13.3	4
Ti 42.8823	4549.788	+0.020	.....	4549 808			
S 43.0712	4552.529	.....	+0.018	4552.750	−0.203	13.4	1
Ti 43.8492	4563.926	+0.013	.....	4563.939			
S 44.1047	4567.708	.....	+0.007	4567.950	−0.235	15.4	1
Ti 44.4036	Standard	±0.000	.....	4572.156			2
S 44.5777	4574.759	.....	±0.000	4574.900	−0.141	9.2	

Curvature Cor.+0.0001 mm. Weighted mean −13.1 Mean −13.4

V_a +28.31
V_d + 0.19

Reduction to Sun +28.50
Radial Velocity +15.4 km.

γ ORIONIS — A 258

1901, October 2, G. M. T. $21^h 34^m$ — Measured by A.
Hour angle E $0^h 47^m$ — Star good; comparison good. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m	t. m.	km.	
Ti 18.1261	Standard	±0.000	.....	4338.084			
S 18.3507	4340.474	.....	−0.001	4340.634	−0.161	−11.1	1
Ti 22.5613	4387.039	−0.032	.....	4387.007			
S 22.6451	4388.001	.....	−0.032	4388.100	−0.131	9.0	2
Ti 23.6768	4399.961	−0.026	.....	4399.935			
S 24.9370	4414.871	.....	−0.016	4415.076	−0.221	15.0	1
Ti 25.9640	4427.274	−0.008	.....	4427.266			
S 26.7986	4437.526	.....	−0.004	4437.718	−0.196	13.2	1
Ti 27.7427	Standard	±0.000	.....	4449.313			
Ti 29.2569	4468.653	+0.010	.....	4468.663			
S 29.4801	4471.551	.....	+0.013	4471.676	−0.112	7.5	2
S 30.2139	4481.163	.....	+0.026	4481.400	−0.211	14.1	1
Ti 30.2328	4481.412	+0.026	.....	4481.438			
Ti 36.1383	Standard	±0.000	.....	4563.939			
S 36.3967	4567.774	.....	±0.000	4567.950	−0.176	11.6	1

Curvature Cor. +0.0001 mm. — Weighted mean −10.9 — Mean −11.6

V_a +26.61
V_d + 0.07
Reduction to Sun +26.68
Radial Velocity +15.8 km.

γ ORIONIS — B 221

1901, November 8, G. M. T. $20^h 38^m$ — Measured by A.
Hour angle W $0^h 32^m$ — Star fair; comparison good. — Power 14

Ti 20.0778	Standard	±0.000	.....	4338.084			
S 20.4093	4340.706	.....	−0.001	4340.634	+0.071	+4.9	1
Ti 26.0447	4387.035	−0.028	.....	4387.007			
S 26.1716	4388.118	.....	−0.026	4388.100	−0.008	−0.6	2
Ti 27.5425	Standard	±0.000	.....	4399.935			
Ti 35.0484	4468.668	−0.005	.....	4468.663			
S 35.3560	4471.642	.....	−0.004	4471.676	−0.038	−2.5	1
Ti 36.3606	Standard	±0.000	.....	4481.438			
S 36.3629	4481.461	.....	±0.000	4481.400	+0.061	+4.1	1
S 43.2799	4552.791	.....	±0.000	4552.750	+0.041	+2.7	1
Ti 43.5444	Standard	±0.000	.....	4555.662			
Ti 44.3037	4563.962	−0.023	.....	4563.939			
S 44.6755	4568.060	.....	−0.018	4567.950	+0.092	+6.0	3
Ti 46.6437	4590.128	−0.002	.....	4590.126			
Ti 49.0040	Standard	±0.000	.....	4617.452			
Ti 52.2489	4656.637	+0.007	.....	4656.644			
Ti 54.2731	Standard	±0.000	.....	4682.088			
Ti 56.4512	4710.389	−0.021	.....	4710.368			
S 56.6702	4713.289	.....	−0.021	4713.308	−0.040	−2.5	3

Curvature Cor. +0.0009 mm. — Weighted mean + 1.6 — Mean +1.7

V_a +15.47
V_d − 0.05
Reduction to Sun +15.42
Radial Velocity +17.0 km.

γ ORIONIS—B 221

Measured by F.
Power 15

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 30.0031	Standard	±0.000	.....	4387.007			
S 30.1385	4388.164	.....	−0.001	4388.100	+0.063	+ 4.3	3
S 33.2198	4415.067	.....	−0.035	4415.076	−0.044	− 3.0	1
Ti 33.2198	4417.922	−0.038	.....	4417.884			
Ti 38.7276	4465.997	−0.022	.....	4465.975			
S 39.3271	4471.773	.....	−0.014	4471.676	+0.083	+ 5.6	3
Ti 40.3191	Standard	±0.000	.....	4481.438			
S 40.3285	4481.540	.....	±0.000	4481.400	+0.140	+ 9.4	½
Ti 47.2247	4552.601	+0.031	.....	4552.632			
S 47.2543	4552.924	.....	+0.031	4552.750	+0.202	+13.3	1½
Ti 47.5037	4555.627	+0.035	.....	4555.662			
S 48.6214	4567.875	.....	+0.016	4567.950	−0.059	− 3.9	1
Ti 50.6058	Standard	±0.000	.....	4590.126			

Curvature Cor. + 0.0013 mm.

Weighted mean + 4.8 Mean + 4.3

V_a +15.47

V_d − 0.05

Reduction to Sun +15.42

Radial Velocity +20.2 km.

γ ORIONIS—B 253

1901, November 27, G. M. T. $21^h\ 55^m$
Hour angle W $3^h\ 8^m$

Star strong; not quite centrally between comparison spectra.

Measured by F.
Power 14

S 29.9085	4340.732	.....	+0.067	4340.634	+0.165	+11.4	2
Ti 29.9995	4341.463	+0.067	.....	4341.530			
Ti 35.4665	Standard	±0.000	.....	4387.007			
S 35.6305	4388.424	.....	±0.000	4388.100	+0.324	22.1	2
Ti 39.9935	4427.264	+0.002	.....	4427.266			
S 41.1325	4437.783	.....	−0.001	4437.718	+0.064	4.3	½
Ti 42.3615	4449.318	−0.005	.....	4449.313			
Ti 44.1005	Standard	±0.000	.....	4465.975			
S 44.7040	4471.850	.....	+0.004	4471.676	+0.178	11.9	3
Ti 45.6765	4481.423	+0.013	.....	4481.438			
S 45.7025	4481.680	.....	+0.013	4481.400	+0.293	19.6	½
Ti 52.5135	4552.592	+0.040	.....	4552.632			
S 52.5510	4553.002	.....	+0.035	4552.750	+0.287	18.9	1
Ti 52.7915	4555.638	+0.024	.....	4555.662			
S 53.9210	4568.144	.....	+0.020	4567.950	+0.214	14.0	2
Ti 55.8615	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0015 mm.

Weighted mean +14.7 Mean +14.6

V_a +6.75

V_d −0.25

Reduction to Sun + 6.50

Radial Velocity +21.2 km.

γ *ORIONIS*—B 262

1902, December 31, G. M. T. $15^h\ 38^m$ — Measured by A.
Hour angle E $0^h\ 58^m$ — Star good; comparison good. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 30.1486	4471.434	−0.026	.....	4471.408			
S 30.2116	4472.051	.....	−0.026	4471.676	+0.349	+23.4	2
Ti 31.1632	Standard	±0.000	.....	4481.438			
Ti 37.9928	4552.617	+0.015	.....	4552.632			
S 38.0449	4553.187	.....	+0.015	4552.750	+0.452	29.8	1
Ti 41.3381	Standard	±0.000	.....	4590.126			
S 41.4567	4591.490	.....	±0.000	4591.066	+0.424	27.7	1
S 44.0480	4621.909	.....	+0.023	4621.549	+0.383	24.8	1
Ti 44.1603	4623.255	+0.023	.....	4623.279			
S 46.3328	4649.742	.....	+0.012	4649.250	+0.504	32.5	2
Ti 46.8864	4656.635	+0.009	.....	4656.644			
Ti 50.1830	4698.940	+0.006	.....	4698.946			
S 50.2450	4699.757	.....	+0.006	4699.340	+0.423	27.0	2
Ti 51.0447	Standard	±0.000	.....	4710.368			
S 51.2930	4713.690	.....	±0.000	4713.308	+0.382	24.3	2

Curvature Cor. +0.0008 mm. — Weighted mean +27.0 — Mean +27.1

V_a −10.03
V_d + 0.09
Reduction to Sun − 9.94
Radial Velocity +17.1 km.

γ *ORIONIS*—B 262

Measured by F.
Power 12

Ti 35.003	4341.413	+0.117	.....	4341.530			
S 34.936	4340.873	.....	+0.119	4340.634	+0.358	+24.7	1
Ti 40.467	Standard	±0.000	.....	4387.007			
S 40.633	4388.443	.....	±0.000	4388.100	+0.343	23.4	2
Ti 44.988	4427.267	−0.001	.....	4427.266			
S 46.158	4438.088	.....	−0.017	4437.718	+0.353	23.8	½
Ti 46.420	4440.535	−0.020	.....	4440.515			
Ti 49.092	4465.995	−0.020	.....	4465.975			
S 49.729	4472.204	.....	−0.013	4471.676	+0.515	34.5	2
Ti 50.666	Standard	±0.000	.....	4481.438			
S 50.690	4481.676	.....	±0.000	4481.400	+0.276	18.5	1
Ti 57.498	4552.615	+0.017	.....	4552.632			
S 57.553	4553.212	.....	+0.019	4552.750	+0.481	31.7	1½
Ti 57.774	4555.635	+0.027	.....	4455.662			
S 58.936	4568.509	.....	+0.018	4567.950	+0.577	37.9	1
S 59.550	4575.402	.....	+0.011	4574.900	+0.513	33.6	½
Ti 60.843	Standard	±0.000	.....	4590.126			
S 60.963	4591.507	.....	−0.001	4591.066	+0.440	28.7	½
Ti 67.276	4667.868	−0.100	.....	4667.768			
Ti 69.689	4699.101	−0.155	.....	4698.946			
Ti 70.551	4710.558	−0.190	.....	4710.368			
S 70.807	4713.992	.....	−0.201	4713.308	+0.483	30.7	1

Curvature Cor. +0.001 mm. — Weighted mean +28.9 — Mean +28.8

V_a −10.03
V_d + 0.09
Reduction to Sun − 9.94
Radial Velocity +19.0 km.

1902, March 13, G. M. T. $15^h\ 53^m$ — *γ ORIONIS*—B 299 — Measured by A.
Hour angle W $3^h\ 58^m$ — Star fair; comparison good. — Power 20

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 18.2322	Standard	±0.000	.....	4338.084			
S 21.8613	4367.681	.....	−0.021	4367.012	+0.648	+44.5	2
Ti 21.8827	4367.860	−0.021	.....	4367.839			
S 27.6440	4417.817	.....	−0.062	4417.121	+0.634	43.0	1
Ti 27.6583	4417.946	−0.062	.....	4417.884			
Ti 32.8061	Standard	±0.000	.....	4465.975			
S 33.4598	4472.321	.....	+0.008	4471.676	+0.653	43.8	2
Ti 34.3868	4481.420	+0.018	.....	4481.438			
S 34.4508	4482.052	.....	+0.018	4481.400	+0.670	44.8	1
Ti 42.2737	4563.904	+0.035	.....	4563.939			
S 42.6999	4568.637	.....	+0.022	4567.950	+0.709	46.5	2
Ti 43.0140	4572.145	+0.011	.....	4572.156			
Ti 44.6012	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0008 mm. Weighted mean +44.7 Mean +44.5

V_a −28.63
V_d − 0.29

Reduction to Sun −28.92
Radial Velocity +15.8 km.

1902, April 9, G. M. T. $15^h\ 4^m$ — *γ ORIONIS*—B 317 — Measured by A.
Hour angle W $4^h\ 56^m$ — Star too weak; comparison strong. — Power 17

Ti 22.9221	Standard	±0.000	.....	4387.007			
S 23.1170	4388.687	.....	±0.000	4388.100	+0.587	+40.1	2
Ti 31.5791	4465.985	−0.010	.....	4465.975			
S 32.2371	4472.376	.....	−0.006	4471.676	+0.694	46.5	3
Ti 33.1599	Standard	±0.000	.....	4481.438			
S 33.2137	4481.970	.....	±0.000	4481.400	+0.570	38.1	1
Ti 40.0166	4552.609	+0.023	.....	4552.632			
S 40.0909	4553.420	.....	+0.022	4552.750	+0.692	45.6	1
Ti 43.3733	Standard	±0.000	.....	4590.126			
S 43.5163	4591.766	.....	±0.000	4591.066	+0.692	45.7	1

Curvature Cor. +0.0008 mm. Weighted mean +43.6 Mean +43.2

V_a −24.92
V_d − 0.33

Reduction to Sun −25.25
Radial Velocity +18.4 km.

γ ORIONIS—B 317 — Measured by F.
Power 12

Ti 35.001	Standard	±0.000	.....	4387.007			
S 35.188	4388.618	.....	±0.000	4388.109	+0.518	+35.4	2
Ti 37.764	4411.224	+0.016	.....	4411.240			
S 38.287	4415.903	.....	+0.010	4415.076			1
Ti 40.294	4434.187	−0.019	.....	4434.168	+0.837	+56.8	1
S 40.739	4438.303	.....	−0.019	4437.718	+0.566	38.2	1
Ti 43.662	4465.993	−0.018	.....	4465.975			
S 44.318	4472.368	.....	−0.007	4671.676	+0.685	45.9	2
Ti 44.590	Standard	±0.000	.....	4475.026			
Ti 52.100	4552.616	+0.016	.....	4552.632			
Ti 52.782	4560.076	+0.026	.....	4560.102			
S 53.363	4568.730	.....	+0.018	4567.950	+0.798	52.4	1
Ti 55.457	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.001 mm. Weighted mean +44.3 Mean +45.7

V_a −24.92
V_d − 0.33

Reduction to Sun −25.25
Radial Velocity +19.0 km.

SUMMARY OF MEASURES OF γ *ORIONIS*

Plate	Date	Adams	No. of Lines	Frost	No. of Lines
A 224	1901, Sept. 11	+15.4	7	.....	..
A 258	Oct. 2	+15.8	7	.....	..
B 221	Nov. 8	+17.0	7	+20.2	6
B 253	Nov. 27	.....	..	+21.2	7
B 262	Dec. 31	+17.1	7	+19.0	10
B 299	1902, Mar. 13	+15.8	5	.....	..
B 317	Apr. 9	+18.4	5	+19.0	4
	Mean	+16.6		+20.1	

Mean of 7 plates +17.6 km.
Mean of all measures +18.0 km.

7. ϵ *ORIONIS*

(R. A. = 5^h 31^m; Dec. = $-1°$ 16′; Mag. 1.8; Class IIa)

Four plates of this star have been measured, three by F., and four by A. All of the lines in its spectrum are extremely broad and ill-defined, and the accuracy of measurement is probably less than for any other star in the list.

ϵ *ORIONIS*—A 208

1901, September 4, G. M. T. 22^h 10^m — Measured by A.
Hour angle E 2^h 23^m — Star rather strong; comparison good. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 23.5347	Standard	±0.000	.....	4338.084			
Ti 34.7160	Standard	±0.000	.....	4468.663			
S 34.9557	4471.762	.....	±0.000	4471.676	+0.086	+5.8	2
S 35.6890	4481.331	.....	+0.017	4481.400	−0.052	−3.5	2
Ti 35.6959	4581.421	+0.017	.....	4481.438			
Ti 40.8525	4552.648	−0.016	.....	4552.632			
S 40.8598	4552.738	.....	−0.016	4552.750	−0.012	−0.8	1
Ti 41.6242	Standard	±0.000	.....	4563.939			

Curvature Cor. +0.0002 mm. — Weighted mean + 0.8 — Mean +0.5

V_a +26.52
V_d + 0.20
Reduction to Sun +26.72
Radial Velocity +27.5 km.

ϵ *ORIONIS*—B 228

1901, November 13, G. M. T. 19^h 50^m — Measured by A.
Hour angle E 0^h 29^m — Star good; comparison strong. — Power 17

S 14.5020	4340.974	.....	±0.000	4340.634	+0.340	+23.5	2
Ti 14.9362	Standard	±0.000	.....	4344.451			
Ti 20.1023	4387.071	−0.064	.....	4387.007			
S 20.2495	4388.328	.....	−0.064	4388.100	+0.164	11.2	1½
S 29.4612	4472.034	.....	−0.006	4471.676	+0.352	23.6	
Ti 30.4276	Standard	±0.000	.....	4481.438			
Ti 37.3358	4552.527	+0.105	.....	4552.632			
S 37.3726	4552.925	.....	+0.105	4552.750	+0.280	18.4	½
Ti 38.3732	4563.827	+0.112	.....	4563.939			
S 38.7533	4568.011	.....	+0.111	4567.950	+0.172	11.3	1
Ti 50.5289	Standard	±0.000	.....	4710.368			
S 50.7662	4713.516	.....	±0.000	4713.308	+0.208	13.2	4

Curvature Cor. +0.0008 mm. — Weighted mean +15.0 — Mean +16.9

V_a +13.73
V_d + 0.04
Reduction to Sun +13.77
Radial Velocity +28.8 km.

ε *ORIONIS*—B 228

Measured by F.
Power 12

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
S 30.777	4340.670	.....	±0.000	4340.634	+0.036	+2.5	1
Ti 30.855	Standard	±0.000	.....	4341.530			
Ti 36.390	4386.945	+0.062	.....	4387.007			
S 36.511	4387.982	.....	+0.062	4388.100	−0.058	−4.0	1
Ti 45.122	4465.995	−0.020	.....	4465.975			
S 45.734	4471.891	.....	−0.016	4471.676	+0.199	+13.3	2
Ti 48.216	Standard	±0.000	.....	4496.318			
Ti 53.626	4552.612	+0.020	.....	4552.632			
S 53.648	4552.850	.....	+0.020	4552.750	+0.120	+7.9	½
Ti 66.817	Standard	±0.000	.....	4710.368			
S 67.057	4713.548	.....	±0.000	4713.308	+0.240	+15.3	3

Curvature Cor. +0.001 mm. Weighted mean +10.0 Mean + 7.0

V_a +13.73
V_d + 0.04

Reduction to Sun +13.77
Radial Velocity +23.8 km.

ε *ORIONIS*—B 298

1902, March 13, G. M. T. 15h 11m
Hour angle W 3h 8m

Star rather weak; comparison good.

Measured by A.
Power 14

Ti 17.9470	Standard	±0.000	.....	4338.084			
S 18.3666	4341.438	.....	−0.004	4340.634	+0.800	+55.3	2
Ti 23.8632	4387.075	−0.068	.....	4387.007			
S 24.0978	4389.096	.....	−0.068	4388.100	+0.938	63.4	2
Ti 25.3515	4400.001	−0.066	.....	4399.935			
Ti 32.7994	4468.687	−0.024	.....	4468.663			
S 33.1848	4472.435	.....	−0.017	4471.676	+0.742	49.8	1
Ti 34.1023	Standard	±0.000	.....	4481.438			
Ti 41.9902	4563.879	+0.060	.....	4563.939			
S 42.4164	4568.609	.....	+0.057	4567.950	+0.716	47.0	1
S 48.5112	4639.666	.....	+0.011	4638.937	+0.740	47.8	2
Ti 49.8867	Standard	±0.000	.....	4656.644			

Curvature Cor. +0.0008 mm. Weighted mean +53.7 Mean +52.6

V_a −27.23
V_d − 0.25

Reduction to Sun −27.48
Radial Velocity +26.2 km.

ε *ORIONIS*—B 298

Measured by F.
Power 12

Ti 35.000	Standard	±0.000	.....	4387.007			
S 35.236	4389.041	.....	±0.000	4388.100	+0.941	+64.3	2
Ti 44.222	4471.442	−0.034	.....	4471.408			
S 44.308	4472.280	.....	−0.031	4471.676	+0.573	38.4	2
Ti 45.241	Standard	±0.000	.....	4481.438			
Ti 52.100	4552.603	+0.029	.....	4552.632			
S 52.199	4553.683	.....	+0.029	4552.750	+0.962	63.4	½
Ti 53.129	4563.901	+0.038	.....	4563.939			
S 53.574	4568.840	.....	+0.039	4567.950	+0.929	61.0	½
Ti 55.455	4590.082	+0.044	.....	4590.126			
Ti 61.024	Standard	±0.000	.....	4656.644			

Curvature Cor. +0.001 mm. Weighted Mean +53.5 Mean +56.8

V_a −27.23
V_d − 0.25

Reduction to Sun − 27.48
Radial Velocity + 26.1 km.

ε ORIONIS—B 316

1902, April 9, G. M. T. $14^h\ 21^m$ — Measured by A.
Hour angle W $4^h\ 8^m$ — Star fair; comparison good. — Power 17

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 24.3317	Standard	±0.000	.....	4338.084			
S 24.7620	4341.517	.....	±0.000	4340.634	+0.883	+61.1	1
Ti 30.2485	4387.016	−0.009	.....	4387.007			
S 30.4698	4388.921	.....	−0.009	4388.100	+0.812	55.5	1
Ti 31.7366	Standard	±0.000	.....	4389.935			
Ti 39.1836	4468.671	−0.008	.....	4468.663			
S 39.5633	4472.370	.....	−0.006	4471.676	+0.688	46.1	3
Ti 40.4855	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0008 mm. — Weighted mean +51.0 — Mean +54.2

V_a −24.24
V_d − 0.30
Reduction to Sun −24.54
Radial Velocity +26.5 km.

ε ORIONIS—B 316 — Measured by F. Power 12

Ti 35.001	Standard	±0.000	.....	4387.007			
S 35.213	4388.835	.....	±0.000	4388.100	+0.735	+50.2	1
Ti 43.659	4466.001	−0.026	.....	4465.975			
S 44.327	4472.489	.....	−0.018	4471.676	+0.795	53.3	2
Ti 45.239	4481.444	−0.006	.....	4481.438			
Ti 48.354	Standard	±0.000	.....	4512.906			
Ti 53.127	4563.915	+0.024	.....	4563.939			
S 53.562	4568.742	.....	+0.015	4567.950	+0.807	53.0	½
Ti 55.456	4590.129	−0.003	.....	4590.126			
Ti 61.022	Standard	±0.000	.....	4656.644			

Curvature Cor. +0.001 mm. — Weighted mean +52.4 — Mean +52.2

V_a −24.24
V_d − 0.30
Reduction to Sun −24.54
Radial Velocity +27.8 km.

SUMMARY OF MEASURES OF *ε ORIONIS*

Plate	Date	Adams	No. of Lines	Frost	No. of Lines
A 208	1901, Sept. 4	+27.5	3	.....	..
B 228	Nov. 13	+28.8	6	+23.8	5
B 298	1902, March 13	+26.2	5	+26.1	4
B 316	April 9	+26.5	3	+27.8	3
	Mean	+27.2		+25.9	

Mean of 4 plates +26.8 km.
Mean of all measures +26.7 km.

8. *ζ ORIONIS*

(R. A. = $5^h\ 36^m$; Dec. = $-2°\ 0'$; Mag. 1.9; Class IIb)

Five plates of this star have been measured, five by A., and two by F. The spectrum is extremely difficult of measurement, the lines being few in number, and extremely broad and ill defined. The degree of accuracy attained is probably about the same as in the case of *ε Orionis*.

ζ ORIONIS — A 263

1901, October 3, G. M. T. $20^h\,42^m$ — Measured by A.
Hour angle E $1^h\,56^m$ — Star strong; comparison good. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 21.3208	Standard	±0.000	.....	4338.084			
S 21.5491	4340.513	.....	±0.000	4340.634	−0.121	− 8.4	2
Ti 24.0571	4367.836	+0.003	.....	4367.839			
Ti 25.7550	4387.026	−0.019	.....	4387.007			
S 25.8352	4387.947	.....	−0.017	4388.100	−0.170	11.6	3
Ti 26.8690	Standard	±0.000	.....	4399.935			
Ti 29.1549	4427.249	+0.017	.....	4427.266			
S 29.9907	4437.524	.....	+0.013	4437.718	−0.181	12.2	2
Ti 32.4466	4468.655	+0.008	.....	4468.663			
S 32.6629	4471.467	.....	+0.006	4471.676	−0.203	13.6	2
Ti 33.4230	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0002 mm. — Weighted mean −11.5 — Mean −11.2

V_a +25.58
V_d + 0.17
Reduction to Sun +25.75
Radial Velocity +14.3 km.

ζ ORIONIS — A 263

Measured by F.
Power 12

Ti 31.0582	Standard	±0.000	.....	4338.084			
S 31.2891	4340.543	.....	−0.002	4340.634	−0.093	−6.4	1
Ti 36.6062	4399.977	−0.042	.....	4399.935			
Ti 42.1840	4468.668	−0.005	.....	4468.663			
S 42.4116	4471.623	.....	−0.004	4471.676	−0.057	3.8	1
Ti 43.1606	Standard	±0.000	.....	4481.438			
Ti 49.0647	Standard	±0.000	.....	4563.939			

Curvature Cor. +0.0003 mm. — Weighted mean −5.1 — Mean −5.1

V_a +25.58
V_d + 0.17
Reduction to Sun +25.75
Radial Velocity +20.8 km.

ζ ORIONIS — B 429

1902, October 23, G. M. T. $23^h\,45^m$ — Measured by A.
Hour angle W $2^h\,25^m$ — Star good; comparison weak. — Power 21

Ti 21.1865	Standard	±0.000	.....	4338.084			
S 21.5038	4340.609	.....	±0.000	4340.634	−0.025	−1.7	1
S 27.2283	4387.981	.....	±0.000	4388.100	−0.119	8.1	1
Ti 28.0643	Standard	±0.000	.....	4395.201			
S 30.3115	4415.012	.....	+0.006	4415.076	−0.058	3.9	1
Ti 31.6671	4427.256	+0.010	.....	4427.266			
Ti 36.0733	Standard	±0.000	.....	4468.663			
S 36.3683	4471.527	.....	±0.000	4471.676	−0.149	10.0	1

Curvature Cor. +0.0008 mm. — Weighted mean −5.9 — Mean −5.9

V_a +21.40
V_d − 0.20
Reduction to Sun +21.20
Radial Velocity +15.3 km.

ζ ORIONIS—B 433

1902, October 29, G. M. T. $19^h\ 4^m$ — Star good; comparison good. — Measured by A.
Hour angle E $1^h\ 52^m$ — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 21.3584	Standard	±0.000	.....	4338.084			
S 21.6687	4340.560	.....	±0.000	4340.634	−0.074	−5.1	2
S 24.9074	4366.995	.....	+0.004	4367.012	−0.013	−0.9	2
S 27.4009	4388.120	.....	+0.007	4388.100	+0.027	+1.8	1
Ti 28.2178	4395.193	+0.008	.....	4395.201			
Ti 28.7605	Standard	±0.000	.....	4399.935			
S 32.8392	4437.701	.....	+0.015	4437.718	−0.002	−0.1	2
Ti 33.6183	4443.959	+0.017	.....	4443.976			
Ti 36.2094	4468.670	−0.007	.....	4468.663			
S 36.5154	4471.647	.....	−0.005	4471.676	−0.034	−2.3	2
Ti 37.5123	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0008 mm. — Weighted mean − 1.6 — Mean −0.7

V_a +19.67
V_d + 0.16
Reduction to Sun +19.83
Radial Velocity +18.2 km.

ζ ORIONIS—B 434

1902, October 29, G. M. T. $19^h\ 45^m$ — Star good; comparison good. — Measured by A.
Hour angle E $1^h\ 12^m$ — Power 21

Ti 20.1420	Standard	±0.000	.....	4338.084			
S 20.4650	4340.662	.....	±0.000	4340.634	+0.028	+ 1.9	1
S 26.1626	4387.943	.....	−0.003	4388.100	−0.160	−10.9	1
Ti 27.0014	4395.205	−0.004	.....	4395.201			
Ti 27.5428	Standard	±0.000	.....	4399.935			
Ti 34.9950	4468.682	−0.019	.....	4468.663			
S 35.3017	4471.665	.....	−0.015	4471.676	−0.026	− 1.7	3
Ti 36.2973	Standard	±0.000	.....	4481.438			

Curvature Cor. + 0.0008 mm. — Weighted mean − 2.9 — Mean −3.6

V_a +19.66
V_d + 0.11
Reduction to Sun +19.77
Radial Velocity +16.9 km.

ζ ORIONIS—B 441

1902, October 30, G. M. T. $21^h\ 19^m$ — Star strong; comparison good. — Measured by A.
Hour angle W $0^h\ 27^m$ — Power 21

Ti 20.3207	Standard	±0.000	.....	4338.084			
S 20.6480	4340.692	.....	±0.000	4340.634	+0.058	+ 4.0	1
S 26.3658	4388.067	.....	+0.001	4388.100	−0.032	− 2.2	1
Ti 27.1909	4395.200	+0.001	.....	4395.201			
Ti 27.7336	Standard	±0.000	.....	4399.935			
Ti 35.1942	4468.676	−0.013	.....	4468.663			
S 35.4940	4471.589	.....	−0.010	4471.676	−0.097	− 6.5	1
Ti 36.4984	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0008 mm. — Weighted mean − 1.6 — Mean −1.6

V_a +19.31
V_d − 0.04
Reduction to Sun +19.27
Radial Velocity +17.7 km.

ζ ORIONIS—B 441 Measured by F.
Power 12

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 30.1739	Standard	±0.000	.....	4338.084			
S 30.5197	4340.840	.....	±0.000	4340.634	+0.206	+14.2	1
Ti 33.8288	4367.844	−0.005	.....	4367.839			
S 36.2503	4388.347	.....	−0.022	4388.100	+0.225	15.4	1
Ti 37.5895	4399.968	−0.033	.....	4399.935			
S 39.5276	4417.155	.....	−0.026	4417.121	+0.008	0.5	2
Ti 39.6117	4417.910	−0.026	.....	4417.884			
Ti 45.0495	Standard	±0.000	.....	4468.663			
S 45.3616	4471.692	.....	±0.000	4471.676	+0.016	1.1	2
Ti 54.9951	Standard	±0.000	.....	4572.156			

Curvature Cor. +0.0013 mm. Weighted mean + 5.5 Mean +7.8

V_a +19.31
V_d − 0.04

Reduction to Sun +19.27
Radial Velocity +24.7 km.

SUMMARY OF MEASURES OF *ζ ORIONIS*

Plate	Date	Adams	No. of Lines	Frost	No. of Lines
A 263	1901, Oct. 3	+14.3	4	+20.6	2
B 429	1902, Oct. 23	+15.3	4	.....	..
B 433	Oct. 29	+18.2	5	.....	..
B 434	Oct. 29	+16.9	3	.....	..
B 441	Oct. 30.	+17.7	3	+24.7	4
	Mean	+16.5		+22.7	

Mean of 5 plates +17.8 km.
Mean of all measures +18.3 km.

9. *κ ORIONIS*

(R. A. = 5h 43m; Dec. − 9° 42′; Mag. 2.2; Class IIα)

Seven plates of the spectrum of this star have been measured, seven by A., and three by F. The spectrum is one of the most difficult of measurement of any we have encountered, all the lines being very broad and diffuse. Traces of a few oxygen lines appear.

1901, September 20, G. M. T. 22h 13m
Hour angle E 1h 23m

κ ORIONIS—A 244
Star good; comparison good.

Measured by A.
Power 21

Ti 18.0699	Standard	±0.000	.....	4338.084			
S 18.3024	4340.560	.....	−0.001	4340.634	−0.075	− 5.2	1
S 19.2999	4351.296	.....	−0.009	4351.495	−0.208	14.3	1
S 22.5847	4387.979	.....	−0.031	4388.100	−0.152	10.4	1
Ti 23.2128	4395.237	−0.036	.....	4395.201			
Ti 27.2579	Standard	±0.000	.....	4443.976			
Ti 29.1978	4468.656	+0.007	.....	4468.663			
S 29.4133	4471.452	.....	+0.008	4471.676	−0.216	14.5	1
Ti 35.3084	4552.591	+0.041	.....	4552.632			
S 35.3104	4552.620	.....	+0.041	4552.750	−0.089	5.9	2
Ti 36.0815	Standard	±0.000	.....	4563.939			

Curvature Cor. +0.0001 mm. Weighted mean − 9.3 Mean −10.0

V_a +24.79
V_d + 0.12

Reduction to Sun +24.91
Radial Velocity +15.6 km.

κ ORIONIS — B 244

Measured by F.
Power 12

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 28.9995	Standard	±0.000	.....	4338.084			
S 29.2247	4340.480	.....	−0.002	4340.634	−0.156	−10.8	1
S 33.5033	4387.817	.....	−0.040	4388.100	−0.323	−22.1	2
Ti 34.1468	4395.247	−0.046	.....	4395.201			
Ti 40.1331	Standard	±0.000	.....	4468.663			
S 40.3438	4471.397	.....	+0.006	4471.676	−0.273	−18.3	2½
Ti 41.1062	4481.409	+0.029	.....	4481.438			
Ti 46.2450	4552.632	±0.000	.....	4552.632			
S 46.2533	4552.753	.....	+0.003	4552.750	+0.003	+ 0.2	1
Ti 47.0149	Standard	±0.000	.....	4563.939			
S 47.2816	4567.896	.....	−0.011	4567.950	−0.065	− 4.3	1
Ti 47.5686	4572.179	−0.023	.....	4572.156			

Curvature Cor. +0.0003 mm. Weighted mean −14.0 Mean −11.1

V_a +24.79
V_d + 0.12
Reduction to Sun +24.91
Radial Velocity +10.9 km.

κ ORIONIS — A 250

1901, September 26, G. M. T. 21h 26m
Hour angle E 1h 50m
Star fair; comparison rather strong.

Measured by A.
Power 21

Ti 37.3388	Standard	±0.000	.....	4387.007			
Ti 38.4583	4399.949	−0.014	.....	4399.935			
S 39.7340	4415.011	.....	−0.017	4415.076	−0.082	−5.6	1
Ti 40.7524	4427.285	−0.019	.....	4427.266			
S 41.5941	4437.596	.....	−0.022	4437.718	−0.144	9.7	1
Ti 42.5370	4449.339	−0.026	.....	4449.313			
S 44.2858	4471.661	.....	−0.008	4471.676	−0.023	1.5	1
S 45.0288	4481.366	.....	±0.000	4481.400	−0.034	2.3	1
Ti 45.0343	Standard	±0.000	.....	4481.438			
Ti 50.9555	4563.889	+0.050	.....	4563.939			
S 51.2177	4567.764	.....	+0.043	4567.950	−0.143	9.4	1
Ti 52.7046	Standard	±0.000	.....	4590.126			

Curvature Cor. + 0.0001 mm. Weighted mean − 5.7 Mean − 5.7

V_a +24.55
V_d + 0.16
Reduction to Sun +24.71
Radial Velocity +19.0 km.

κ ORIONIS — B 196

1901, October 17, G. M. T. 19h 24m
Hour angle E 2h 32m
Star good; comparison strong.

Measured by A.
Power 24

Ti 16.8322	Standard	±0.000	.....	4338.084			
S 17.1483	4340.587	.....	−0.001	4340.634	−0.048	− 3.3	1
S 22.9038	4387.966	.....	−0.013	4388.100	−0.147	−10.0	1
Ti 23.7479	4395.216	−0.015	.....	4395.201			
Ti 29.7642	Standard	±0.000	.....	4449.313			
Ti 31.8021	4468.661	+0.002	.....	4468.663			
S 32.1094	4471.626	.....	+0.002	4471.676	−0.048	− 3.2	3
S 33.1156	4481.424	.....	±0.000	4481.400	+0.024	+ 1.6	2
Ti 36.2562	4512.913	−0.007	.....	4481.438			
Ti 40.0244	4552.615	+0.017	.....	4552.632			
S 40.0294	4552.669	.....	+0.017	4552.750	−0.064	− 4.2	2
Ti 41.0622	Standard	±0.000	.....	4563.939			

Curvature Cor. + 0.0002 mm. Weighted mean − 3.2 Mean − 4.0

V_a +21.65
V_d + 0.21
Reduction to Sun +21.86
Radial Velocity +18.7 km.

1901, October 23, G. M. T. $19^h\ 26^m$ — κ *ORIONIS*—A 274 — Measured by A.
Hour angle E $2^h\ 1^m$ — Star slightly weak; comparison good. — Power 25

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
S 25.3793	4388.096	.....	±0.000	4388.100	−0.004	−0.3	1
Ti 25.9954	Standard	±0.000	.....	4395.201			
S 27.6771	4414.992	.....	−0.042	4415.076	−0.126	8.6	1
Ti 27.9227	4417.933	−0.049	.....	4417.884			
Ti 31.9962	Standard	±0.000	.....	4468.663			
S 32.2265	4471.646	.....	±0.000	4471.676	−0.030	2.0	2
Ti 38.8937	Standard	±0.000	.....	4563.939			

Curvature Cor. +0.0002 mm. — Weighted mean − 3.2 — Mean −3.6

V_a +20.27
V_d + 0.17

Reduction to Sun +20.44
Radial Velocity +17.2 km.

1901, October 31, G. M. T. $20^h\ 24^m$ — κ *ORIONIS*—A 285 — Measured by A.
Hour angle E $0^h\ 31^m$ — Star good; comparison good. — Power 21

S 22.9041	4340.626	.....	±0.000	4340.634	−0.008	−0.6	1
Ti 23.2617	Standard	±0.000	.....	4344.451			
S 25.3370	4367.114	.....	−0.042	4367.012	+0.060	+4.1	1
Ti 25.4059	4367.881	−0.042	.....	4367.839			
Ti 27.1045	4387.067	−0.060	.....	4387.007			
S 27.1997	4388.159	.....	−0.060	4388.100	−0.001	−0.1	1
Ti 31.0726	4434.195	−0.027	.....	4434.168			
S 31.3647	4437.799	.....	−0.030	4437.718	+0.051	+3.4	2
Ti 32.2905	4449.349	−0.036	.....	4449.313			
Ti 33.5961	Standard	±0.000	.....	4465.975			
S 34.0413	4471.737	.....	−0.009	4471.676	+0.052	+3.5	2
Ti 34.7844	4481.462	−0.024	.....	4481.438			
Ti 39.9215	4552.599	+0.033	.....	4552.632			
S 39.9269	4552.677	.....	+0.033	4552.750	−0.040	−2.6	2
Ti 40.6932	4563.914	+0.025	.....	4563.939			
S 40.9627	4567.906	.....	+0.019	4567.950	−0.025	−1.6	2
Ti 42.4365	Standard	±0.000	.....	4590.126			
S 42.4965	4591.045	.....	±0.000	4591.066	−0.021	−1.4	2

Curvature Cor. +0.0005 mm. — Weighted mean + 0.5 — Mean +0.6

V_a +18.06
V_d + 0.04

Reduction to Sun +18.10
Radial Velocity +18.6 km.

κ *ORIONIS*—A 285 — Measured by F.
Power 12

Ti 29.9333	4338.076	+0.008	.....	4338.084			
S 30.1773	4340.739	.....	+0.005	4340.634	+0.110	+7.6	1
Ti 30.5306	Standard	±0.000	.....	4344.451			
Ti 34.3743	4387.069	−0.062	.....	4387.007			
S 34.4627	4388.083	.....	−0.061	4388.100	−0.078	−5.3	2
Ti 40.8675	4465.978	−0.003	.....	4465.975			
S 41.3154	4471.774	.....	+0.002	4471.676	+0.106	+7.1	2
Ti 42.0540	Standard	±0.000	.....	4481.438			
Ti 47.1927	4552.572	+0.060	.....	4552.632			
S 47.1932	4552.579	.....	+0.060	4552.750	−0.111	−7.3	3
Ti 51.8296	4623.251	+0.028	.....	4623.279			
Ti 52.2205	Standard	±0.000	.....	4629.521			
S 52.2994	4630.792	.....	±0.000	4630.703	+0.089	+5.8	1

Curvature Cor. +0.0010 mm. — Weighted mean − 0.6 — Mean +1.6

V_a +18.06
V_d + 0.04

Reduction to Sun +18.10
Radial Velocity +17.5 km.

κ ORIONIS — B 297

1902, March 13, G. M. T. $14^h\ 29^m$ — Measured by A.
Hour angle W $2^h\ 14^m$ — Star good; comparison good. — Power 17

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
S 21.8680	4367.614	.....	±0.000	4367.012	+0.602	+41.3	1
Ti 21.8949	Standard	±0.000	.....	4367.839			
Ti 24.1605	4387.044	−0.037	.....	4387.007			
S 24.3606	4388.767	.....	−0.037	4388.100	+0.630	43.1	1
Ti 33.0949	Standard	±0.000	.....	4468.663			
S 33.4630	4472.243	.....	±0.000	4471.676	+0.567	38.0	2
Ti 34.3997	4481.437	+0.001	.....	4481.438			
S 34.4740	4482.172	.....	+0.001	4481.400	+0.773	51.7	1
Ti 41.2577	4552.608	+0.024	.....	4552.632			
S 41.3312	4553.410	.....	+0.024	4552.750	+0.684	45.0	2
Ti 43.0268	4572.147	+0.009	.....	4572.156			
S 43.3334	4575.586	.....	+0.009	4574.900	+0.693	45.4	1
Ti 44.6144	Standard	±0.000	.....	4590.126			
S 45.2168	4597.061	.....	±0.000	4596.291	+0.770	50.2	1

Curvature Cor. +0.0008 mm. — Weighted mean +44.2 — Mean +45.0

V_a −25.04
V_d − 0.19

Reduction to Sun −25.23
Radial Velocity +19.0 km.

κ ORIONIS — B 315

1902, April 9, G. M. T. $13^h\ 47^m$ — Measured by A.
Hour angle W $3^h\ 21^m$ — Star good; comparison good. — Power 17

Ti 19.6236	Standard	±0.000	.....	4338.064			
S 20.0091	4341.163	.....	−0.002	4340.634	+0.527	+36.4	1
S 21.1303	4350.203	.....	−0.007	4349.541	+0.655	45.2	1
Ti 26.4865	4395.234	−0.033	.....	4395.201			
S 29.0385	4417.825	.....	−0.051	4417.121	+0.653	44.3	1
Ti 29.0507	4417.935	−0.051	.....	4417.884			
Ti 34.4790	Standard	±0.000	.....	4468.663			
S 34.8421	4472.193	.....	+0.007	4471.676	+0.524	35.1	4
Ti 35.7819	4481.414	+0.024	.....	4481.438			
S 35.8385	4481.973	.....	+0.024	4481.400	+0.597	40.0	1
Ti 42.6415	4552.582	+0.050	.....	4552.632			
S 42.7170	4553.406	.....	+0.050	4552.750	+0.706	46.5	2
Ti 43.6705	4563.884	+0.055	.....	4563.939			
S 46.1285	4591.592	.....	+0.037	4591.066	+0.563	36.8	1
Ti 48.3430	Standard	±0.000	.....	4617.452			

Curvature Cor. +0.0008 mm. — Weighted mean +39.6 — Mean +40.6

V_a −22.86
V_d − 0.26

Reduction to Sun −23.12
Radial Velocity +16.5 km.

κ ORIONIS — B 315

Measured by F. — Power 12

Ti 30.0110	Standard	±0.000	.....	4338.064			
S 30.4000	4341.189	.....	±0.000	4340.634	+0.555	+38.3	1
Ti 36.8744	4395.214	−0.013	.....	4395.201			
Ti 44.8695	Standard	±0.000	.....	4468.663			
S 45.2435	4472.300	.....	+0.006	4471.676	+0.630	42.2	3
Ti 46.1721	4481.413	+0.025	.....	4481.438			
S 46.2375	4482.083	.....	+0.024	4481.400	+0.683	45.7	1
Ti 53.0331	4552.627	+0.005	.....	4552.632			
S 53.0968	4553.322	.....	+0.005	4552.750	+0.577	38.0	1
Ti 54.0610	4563.923	+0.016	.....	4563.939			
S 54.4791	4568.568	.....	+0.007	4567.950	+0.625	41.0	2
Ti 54.8003	Standard	±0.000	.....	4572.156			

Curvature Cor. +0.0013 mm. — Weighted mean +41.4 — Mean +41.0

V_a −22.86
V_d − 0.26

Reduction to Sun −23.12
Radial Velocity +18.2 km.

SUMMARY OF MEASURES OF κ *ORIONIS*

Plate	Date	Adams	No. of Lines	Frost	No. of Lines
A 244	1901, Sept. 20	+15.6	5	+10.9	5
A 250	Sept. 26	+19.0	5	.....	..
B 196	Oct. 17	+18.7	5	.....	..
A 274	Oct. 23	+17.2	3	.....	..
A 285	Oct. 31	+18.6	8	+17.5	5
B 297	1902, March 13	+19.0	7	.....	..
B 315	April 9	+16.5	7	+18.2	5
	Mean	+17.8		+15.5	

Mean of 7 plates +17.5 km.
Mean of all measures +17.1 km.

10. β *CANIS MAJORIS*

(R. A.=6^h 18^m; Dec.=$-17°54'$; Mag. 2.0; Class III*a*)

Three plates of this star have been measured, two by A., and three by F. Numerous lines of oxygen and nitrogen are present in the spectrum in addition to the regular *Orion* lines, and all are narrow and well defined in character.

β CANIS MAJORIS — A 287

1901, October 31, G. M. T. 21^h 35^m — Star fair; comparison good. — Measured by A.
Hour angle W 0^h 9^m — Power 25

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 20.5223	Standard	±0:000	.....	4344.451			
S 20.6539	4345.866	.....	−0.002	4345.677	+0.187	+12.9	1
S 21.0230	4349.850	.....	−0.008	4349.541	+0.301	20.7	½
S 21.1914	4351.676	.....	−0.011	4351.495	+0.170	11.7	½
S 22.6035	4367.197	.....	−0.036	4367.012	+0.149	10.2	½
Ti 22.6645	4367.876	−0.037	.....	4367.839			
Ti 26.4383	4411.311	−0.071	.....	4411.240			
S 26.7735	4415.310	.....	−0.083	4415.076	+0.151	10.3	2
S 26.9511	4417.438	.....	−0.080	4417.121	+0.227	15.4	½
Ti 26.9959	4417.976	−0.092	.....	4417.884			
Ti 30.8583	4466.035	−0.060	.....	4465.975			
S 31.3058	4471.956	.....	−0.037	4471.676	+0.243	16.3	2
Ti 32.0405	Standard	±0.000	.....	4481.438			
Ti 37.1801	4552.558	+0.074	.....	4552.632			
S 37.2029	4552.890	.....	+0.074	4552.750	+0.214	14.1	2
Ti 37.9534	4563.885	+0.054	.....	4563.939			
S 38.2383	4568.101	.....	+0.053	4567.950	+0.204	13.4	1
Ti 38.5072	4572.103	+0.053	.....	4572.156			
S 38.7063	4575.080	.....	+0.056	4574.900	+0.236	15.5	2
Ti 39.6951	4590.041	+0.085	.....	4590.126			
Ti 41.4542	4617.406	+0.046	.....	4617.452			
S 42.2972	4630.872	.....	+0.036	4630.703	+0.205	13.3	½
S 42.8130	4639.228	.....	+0.029	4638.937	+0.320	20.7	1
S 42.9915	4642.140	.....	+0.027	4641.886	+0.281	18.2	½
S 43.5376	4651.119	.....	+0.020	4650.925	+0.214	13.8	½
Ti 43.8696	4656.628	+0.016	.....	4656.644			
Ti 44.5340	Standard	±0.000	.....	4667.768			
S 45.0520	4676.563	.....	±0.000	4676.290	+0.273	17.5	½

Curvature Cor. +0.0005 mm. — Weighted mean +14.7 — Mean +14.9

V_a +18.84
V_d − 0.01

Reduction to Sun +18.83
Radial Velocity +33.5 km.

β CANIS MAJORIS — A 287

Measured by F.
Power 12

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
S 30.9422	4367.190	.....	±0.000	4367.072	+0.118	+ 8.1	1
Ti 31.0005	Standard	±0.000	.....	4367.839			
Ti 32.7005	4387.060	−0.053	.....	4387.007			
S 32.8075	4388.289	.....	−0.052	4388.100	+0.137	9.4	2
S 35.1105	4415.306	.....	−0.060	4415.076	+0.170	11.5	2
S 35.2828	4417.372	.....	−0.061	4417.121	+0.190	12.9	1
Ti 35.3308	4417.945	−0.061	.....	4417.884			
Ti 39.1925	4466.018	−0.043	.....	4465.975			
S 39.6468	4471.900	.....	−0.028	4471.676	+0.196	13.1	2
Ti 40.3755	Standard	±0.000	.....	4481.438			
S 40.3815	4481.517	.....	±0.000	4481.400	+0.117	7.8	1
Ti 45.5175	4552.620	+0.012	.....	4552.632			
S 45.5428	4552.988	.....	+0.012	4552.750	+0.250	16.5	3
Ti 46.2862	4563.883	+0.056	.....	4563.939			
S 46.5748	4568.156	.....	+0.027	4567.950	+0.233	15.3	2
Ti 46.8430	4572.149	+0.007	.....	4572.156			
S 47.0442	4575.159	.....	+0.006	4574.900	+0.265	17.4	1
Ti 48.0330	Standard	±0.000	.....	4590.126			
S 48.4478	4596.494	.....	+0.001	4596.291	+0.204	13.3	1
Ti 49.7885	4617.445	+0.007	.....	4617.452			

Weighted mean +12.9 Mean +12.5
Curvature Cor. − 0.71
V_a +18.84
V_d − 0.03
Reduction to Sun +18.81
Radial Velocity +31.0 km.

β CANIS MAJORIS—A 293

1901, November 1, G. M. T. 21h 26m
Hour angle W 0h 3m
Star fair; comparison good.

Measured by F.
Power 17

Ti 27.1717	Standard	±0.000	.....	4338.084			
S 27.4256	4340.791	.....	−0.005	4340.634	+0.152	10.5	1
S 31.7221	4388.419	.....	−0.062	4388.100	+0.257	17.6	2
Ti 32.3148	4395.270	−0.069	.....	4395.201			
Ti 32.7200	4399.998	−0.063	.....	4399.935			
S 34.0175	4415.363	.....	−0.064	4415.076	+0.223	15.2	2
S 34.1961	4417.503	.....	−0.063	4417.121	+0.319	21.6	1
Ti 34.2324	4417.939	−0.055	.....	4417.884			
Ti 35.0081	4427.332	−0.066	.....	4427.266			
Ti 38.3000	4468.695	−0.032	.....	4468.663			
S 38.5496	4471.936	.....	−0.009	4471.676	+0.251	16.8	2
Ti 39.2752	Standard	±0.000	.....	4481.438			
Ti 44.4088	4552.552	+0.080	.....	4552.632			
S 44.4375	4552.974	.....	+0.062	4552.750	+0.286	18.8	4
Ti 45.1813	4563.881	+0.058	.....	4563.939			
S 45.4705	4568.169	.....	+0.067	4567.950	+0.286	18.8	3
Ti 45.7344	4572.099	+0.057	.....	4572.156			
S 46.9983	4591.222	.....	+0.064	4591.066	+0.220	14.4	2
Ti 48.6788	4617.416	+0.036	.....	4617.452			
S 50.0322	4639.181	.....	+0.025	4639.206	+0.260	16.8	2
S 50.6555	4649.413	.....	+0.011	4649.424	+0.184	11.9	2
Ti 51.0913	Standard	±0.000	.....	4656.644			

Weighted mean +17.1 Mean +16.2
Curvature Cor. − 0.86
V_a +18.63
V_d 0.00
Reduction to Sun +18.63
Radial Velocity +34.8 km.

β CANIS MAJORIS—B 215

1901, November 7, G. M. T. $21^h\ 00^m$ — Measured by A.
Hour angle, E $0^h\ 8^m$ — Star weak; comparison slightly weak. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 15.9494	Standard	±0.000	.....	4313.034			
S 16.5293	4317.457	.....	−0.005	4317.272	+0.180	+12.5	2
S 16.8567	4319.969	.....	−0.007	4319.762	+0.200	13.9	½
Ti 19.1827	4338.108	−0.024	.....	4338.084			
S 19.5305	4340.866	.....	−0.036	4340.634	+0.196	13.5	½
S 20.6401	4349.745	.....	−0.050	4349.541	+0.154	10.6	1
S 20.8818	4351.696	.....	−0.052	4351.495	+0.145	10.3	½
S 22.7898	4367.308	.....	−0.083	4367.012	+0.213	14.6	½
Ti 22.8641	4367.923	−0.084	.....	4367.839			
Ti 27.9241	4411.280	−0.040	.....	4411.240			
S 28.3726	4415.264	.....	−0.034	4415.076	+0.154	10.5	2
S 28.6063	4417.349	.....	−0.031	4417.121	+0.197	13.4	1
S 30.8757	4437.941	.....	+0.001	4437.718	+0.224	15.1	1
Ti 31.5267	4443.966	+0.010	.....	4443.976			
Ti 34.1367	Standard	±0.000	.....	4468.663			
S 34.4710	4471.890	.....	+0.003	4471.676	+0.217	14.6	1
Ti 35.4497	4481.428	+0.010	.....	4481.438			
S 42.3849	4552.929	.....	+0.105	4552.750	+0.284	18.7	2
Ti 42.6262	4555.548	+0.114	.....	4555.662			
Ti 43.3830	4563.823	+0.116	.....	4563.939			
S 43.7684	4568.072	.....	+0.114	4567.950	+0.236	15.5	3
Ti 44.1265	4572.043	+0.113	.....	4572.156			
Ti 45.7245	4590.020	+0.106	.....	4590.126			
S 45.8308	4591.232	.....	+0.104	4591.066	+0.270	17.6	1
S 46.2829	4596.405	.....	+0.099	4596.291	+0.213	13.9	½
Ti 48.0837	4617.366	+0.086	.....	4617.452			
Ti 48.5765	4623.203	+0.076	.....	4623.279			
S 49.2176	4630.863	.....	+0.063	4630.703	+0.223	14.4	½
S 50.1463	4642.096	.....	+0.044	4641.886	+0.254	16.4	½
S 50.7505	4649.491	.....	+0.029	4649.250	+0.270	17.4	2
Ti 51.3287	4656.634	+0.010	.....	4656.644			
S 51.7620	4662.029	.....	+0.006	4661.728	+0.307	19.7	½
Ti 52.2197	Standard	±0.000	.....	4667.768			

Curvature Cor. +0.0007 mm. — Weighted mean +14.7 — Mean +14.6

V_a +17.24
V_d + 0.01
Reduction to Sun +17.25
Radial Velocity +32.0 km.

β CANIS MAJORIS—B 215

Measured by F.
Power 12

S 29.9290	4367.244	.....	±0.000	4367.072	+0.172	+11.8	1
Ti 30.0008	Standard	±0.000	.....	4367.839			
Ti 32.2802	4387.024	−0.017	.....	4387.007			
S 32.4325	4388.327	.....	−0.015	4388.100	+0.212	14.5	1
S 35.5175	4415.274	.....	−0.026	4415.076	+0.172	11.7	3
S 35.7475	4417.327	.....	−0.032	4417.121	+0.174	11.8	2
Ti 35.8135	4417.918	−0.034	.....	4417.884			
Ti 41.2755	4468.650	+0.013	.....	4468.663			
S 41.6092	4471.874	.....	+0.010	4471.676	+0.208	13.9	2
Ti 42.5900	Standard	±0.000	.....	4481.438			
S 42.5958	4481.498	.....	±0.000	4481.400	+0.098	6.6	1
Ti 43.3002	4488.445	+0.048	.....	4488.493			
Ti 49.4875	4552.585	+0.047	.....	4552.632			
S 49.5212	4552.951	.....	+0.047	4552.750	+0.248	16.3	3
Ti 50.5230	4563.894	+0.045	.....	4563.939			
S 50.9108	4568.173	.....	+0.035	4567.950	+0.258	16.9	2
Ti 51.2672	4572.128	+0.028	.....	4572.156			

β CANIS MAJORIS—B 215—*Continued*

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
S 51.5355	4575.120	.....	+0.023	4574.900	+0.243	+15.9	1½
Ti 52.8655	Standard	±0.000	.....	4590.156			
S 52.9748	4591.372	.....	−0.002	4591.086	+0.304	19.8	1½
S 53.4240	4596.518	.....	−0.011	4596.291	+0.216	14.1	1
Ti 55.2248	4617.499	−0.047	.....	4617.452			

Curvature Cor.+0.0010 mm. Weighted mean +14.2 Mean +13.2

V_a +17.24
V_d + 0.01
Reduction to Sun +17.25
Radial Velocity +31.4 km.

SUMMARY OF MEASURES OF *β CANIS MAJORIS*

Plate	Date	Adams	No. of Lines	Frost	No. of Lines
A 287	1901, Oct. 31	+33.5	15	+31.0	10
A 293	Nov. 1	.....	..	+34.8	10
B 215	Nov. 7	+32.0	18	+31.4	11
	Mean	+32.8		+32.4	

Mean of 3 plates +32.9 km.
Mean of all measures +32.6 km.

11. *ε CANIS MAJORIS*

(R. A.=6ʰ 55ᵐ; Dec.=−28° 50′; Mag. 1.5; Class III*a*)

Three plates of this star have been measured, two by each observer. The spectrum is very similar to that of *β Canis Majoris*, but the oxygen and nitrogen lines are slightly more diffuse in character.

ε CANIS MAJORIS—B 216

1901, November 7, G. M. T. 21ʰ 51ᵐ — Measured by A. with Zeiss Comparator
Hour angle W 0ʰ 8ᵐ — Star good; comparison fair. — Power 20

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 64.9697	Standard	±0.000	.....	4338.084			
S 64.0046	4345.798	.....	−0.008	4345.677	+0.113	+ 7.8	2
S 63.5142	4349.754	.....	−0.012	4349.541	+0.201	13.9	2
S 61.3858	4367.214	.....	−0.030	4367.012	+0.162	11.1	1
Ti 61.3070	4367.869	−0.030	.....	4367.839			
S 58.8970	4388.247	.....	−0.048	4388.100	+0.099	6.8	1
Ti 57.5415	4399.994	−0.059	.....	4399.935			
S 55.8182	4415.236	.....	−0.062	4415.076	+0.098	6.7	2
S 55.5866	4417.311	.....	−0.062	4417.121	+0.128	8.7	2
Ti 55.5158	4417.946	−0.062	.....	4417.884			
S 53.3280	4437.891	.....	−0.014	4437.718	+0.159	10.7	2
Ti 52.6732	Standard	±0.000	.....	4443.976			
Ti 50.0722	4468.693	−0.030	.....	4468.663			
S 49.7430	4471.886	.....	−0.020	4471.676	+0.190	12.7	3
Ti 48.7676	4381.431	+0.007	.....	4481.438			
S 48.7579	4481.527	.....	+0.007	4481.400	+0.134	9.0	1
Ti 41.8927	4552.600	+0.032	.....	4552.632			
S 41.8694	4552.854	.....	+0.032	4552.750	+0.136	9.0	1

ε *CANIS MAJORIS*—B 216—*Continued*

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 40.8595	4563.924	+0.015	.....	4563.939			
S 40.4787	4568.142	.....	+0.006	4567.950	+0.198	13.0	3
Ti 40.1182	4572.157	−0.001	.....	4572.156			
S 39.8528	4575.126	.....	−0.001	4574.900	+0.225	15.0	2
Ti 38.5281	Standard	±0.000	.....	4590.126			
S 38.4293	4591.277	.....	±0.000	4591.066	+0.211	13.8	1

Curvature Cor. −0.0009 mm. Weighted mean +11.0 Mean +10.6

V_a +16.75
V_d − 0.01

Reduction to Sun +16.74
Radial Velocity +27.7 km.

ε *CANIS MAJORIS*—B 451

1902, November 6, G. M. T. $21^h\,47^m$ Measured by A.
Hour angle $0^h\,0^m$ Star good; comparison good. Power 21

Ti 20.2279	Standard	±0.000	.....	4338.084			
S 20.5550	4340.695	.....	−0.002	4340.634	+0.059	+ 4.1	2
S 21.1916	4345.819	.....	−0.006	4345.677	+0.136	9.4	1
Ti 23.8748	4367.863	−0.024	.....	4367.839			
S 26.2804	4388.287	.....	−0.016	4388.100	+0.171	11.7	2
Ti 27.0796	4395.215	−0.014	.....	4395.201			
Ti 27.6206	4399.947	−0.012	.....	4399.935			
S 29.3356	4415.173	.....	−0.021	4415.076	+0.076	5.2	2
S 29.5728	4417.306	.....	−0.022	4417.121	+0.163	11.1	2
Ti 29.6393	4417.906	−0.022	.....	4417.884			
Ti 30.6720	4427.282	−0.016	.....	4427.266			
S 31.8242	4437.899	.....	−0.008	4437.718	+0.173	11.7	2
S 32.8231	4447.239	.....	−0.002	4447.163	+0.074	5.0	1
Ti 33.0490	Standard	±0.000	.....	4449.313			
Ti 35.0637	4468.662	+0.001	.....	4468.663			
S 35.3911	4471.849	.....	−0.001	4471.676	+0.172	11.5	2
Ti 36.3682	4481.446	−0.008	.....	4481.438			
S 36.3732	4481.495	.....	−0.008	4481.400	+0.087	5.8	2
Ti 43.2183	4552.610	+0.022	.....	4552.632			
S 43.2380	4552.825	.....	+0.022	4552.750	+0.096	6.3	2
Ti 44.2484	Standard	±0.000	.....	4563.939			
S 44.6250	4568.124	.....	+0.003	4567.950	+0.177	11.6	2
Ti 44.9852	4572.149	+0.007	.....	4572.156			
S 45.2420	4575.032	.....	+0.007	4574.900	+0.139	9.1	2

Curvature Cor. +0.0008 mm. Weighted Mean + 8.4 Mean +8.2

V_a +16.93
V_d 0.00

Reduction to Sun +16.93
Radial Velocity +25.3 km.

ε *CANIS MAJORIS*—B 451

Measured by F.
Power 12

Ti 30.0044	4338.045	+0.039	.....	4338.084			
S 30.3391	4340.722	.....	+0.036	4340.634	+0.124	+ 8.6	1
S 33.5736	4367.188	.....	±0.000	4367.012	+0.176	12.1	1½
Ti 33.6515	Standard	±0.000	.....	4367.839			
Ti 35.9161	4387.060	−0.053	.....	4387.007			
S 36.0565	4388.263	.....	−0.050	4388.100	+0.113	7.7	1½

ε *CANIS MAJORIS*—B 451—*Continued*

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 37.3995	4399.950	−0.015	.....	4399.935			
S 39.1153	4415.186	.....	−0.024	4415.076	+0.086	+ 5.8	1½
S 39.3501	4417.298	.....	−0.025	4417.121	+0.152	10.3	1
Ti 39.4179	4417.909	−0.025	.....	4417.884			
Ti 44.8424	4468.667	−0.004	.....	4468.663			
S 45.1720	4471.874	.....	−0.003	4471.676	+0.195	13.1	2
Ti 46.1459	Standard	±0.000	.....	4481.438			
Ti 52.9973	4552.589	+0.043	.....	4552.632			
S 53.0178	4552.812	.....	+0.043	4552.750	+0.105	6.9	2
Ti 54.0282	4563.919	+0.020	.....	4563.939			
S 54.4053	4568.108	.....	±0.000	4567.950	+0.158	10.4	2
Ti 54.7696	4572.176	−0.020	.....	4572.156			
S 55.0261	4575.054	.....	−0.017	4574.900	+0.137	9.0	1
Ti 56.3537	Standard	±0.000	.....	4590.126			
S 56.4464	4591.190	.....	−0.001	4591.066	+0.123	8.0	½
S 56.8974	4596.386	.....	−0.006	4596.291	+0.089	5.8	½
Ti 58.6974	4617.483	−0.031	.....	4617.452			

Curvature Cor. +0.0013 mm. Weighted mean + 9.2 Mean +8.9

V_a +16.93

V_d 0.00

Reduction to Sun +16.93

Radial Velocity +26.2 km.

ε *CANIS MAJORIS*—B 461

1902, November 19, G. M. T. 21ʰ 0ᵐ Measured by F.

Hour angle W 0ʰ 2ᵐ Star fair; comparison fair. Power 15

Ti 29.8020	Standard	±0.000	.....	4338.084			
S 33.3811	4367.283	.....	−0.048	4367.012	+0.223	+15.3	1
Ti 33.4534	4367.887	−0.048	.....	4367.839			
Ti 36.6624	4395.260	−0.059	.....	4395.201			
Ti 37.2046	4400.000	−0.065	.....	4399.935			
S 38.9310	4415.320	.....	−0.066	4415.076	+0.178	12.1	1
S 39.1565	4417.347	.....	−0.066	4417.121	+0.160	10.9	1
Ti 39.2234	4417.950	−0.066	.....	4417.884			
Ti 44.6513	4468.706	−0.043	.....	4468.663			
S 44.9806	4471.909	.....	−0.033	4471.676	+0.200	13.4	3
Ti 45.9516	Standard	±0.000	.....	4481.438			
S 45.9703	4481.623	.....	±0.000	4481.400	+0.223	14.9	2
Ti 52.8063	4552.586	+0.046	.....	4552.632			
S 52.8402	4552.955	.....	+0.046	4552.750	+0.251	16.5	3
Ti 53.8358	4563.896	+0.043	.....	4563.939			
S 54.2231	4568.196	.....	+0.027	4567.950	+0.273	17.9	3
Ti 54.5769	4572.145	+0.011	.....	4572.156			
S 54.8412	4575.109	.....	+0.015	4574.900	+0.224	14.7	1
Ti 56.1625	4590.105	+0.021	.....	4590.126			
S 56.7174	4596.492	.....	+0.016	4596.291	+0.217	14.2	1
Ti 58.5062	Standard	±0.000	.....	4617.452			

Curvature Cor. +0.0013 mm. Weighted mean +14.8 Mean +14.4

V_a +14.74

V_d 0.00

Reduction to Sun +14.74

Radial Velocity +29.6 km.

SUMMARY OF MEASURES OF ϵ *CANIS MAJORIS*

Plate	Date	Adams	No. of Lines	Frost	No. of Lines
B 216	1901, Nov. 7	+27.7	13	.....	..
B 451	1902, Nov. 6	+25.3	11	+26.2	11
B 461	Nov. 19	.....	..	+29.6	9
	Mean	+26.5		+27.9	

Mean of 3 plates +27.7 km.
Mean of all measures +27.2 km.

12. η *LEONIS*

(R. A. = $10^h\ 2^m$; Dec. = +17° 15′; Mag. 3.6; Class VIIc)

Three plates of this star have been measured, three by F., and two by A. The spectrum is well advanced toward the Ia2 type, the metallic lines being numerous and well defined. The helium line $\lambda 4471$ is present but weak.

η *LEONIS* — B 329

1902, April 19, G. M. T. $15^h\ 43^m$ — Measured by A.
Hour angle W $1^h\ 38^m$ — Star good; comparison good. — Power 20

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 35.6462	4468.637	+0.026	.....	4468.663			
S 35.6874	4469.037	.....	+0.026	4468.663	+0.400	+26.8	1
Ti 36.9530	Standard	±0.000	.....	4481.438			
S 36.9934	4481.837	.....	±0.000	4481.400	+0.437	29.2	1
Ti 37.6612	4488.474	+0.019	.....	4488.493			
S 37.7913	4489.774	.....	+0.015	4489.351	+0.438	29.3	1
S 38.0125	4491.990	.....	+0.007	4491.570	+0.427	28.5	1
Ti 38.4433	4496.325	−0.007	.....	4496.318			
S 39.6756	4508.874	.....	+0.004	4508.455	+0.423	28.1	1
Ti 40.0663	4512.899	+0.007	.....	4512.906			
S 40.3610	4515.949	.....	+0.005	4515.508	+0.446	29.6	1
S 40.8270	4520.800	.....	+0.002	4520.397	+0.405	26.9	1
Ti 41.0349	Standard	±0.000	.....	4522.974			
Ti 44.0855	4555.644	+0.018	.....	4555.662			
S 44.4158	4559.269	.....	+0.012	4558.827	+0.454	29.9	1
Ti 45.5779	4572.166	−0.010	.....	4572.156			
S 46.0019	4576.928	.....	−0.007	4576.512	+0.409	26.8	1
S 46.6666	4584.453	.....	−0.003	4584.018	+0.432	28.3	1
S 47.0507	4588.835	.....	−0.001	4588.381	+0.453	29.6	1
Ti 47.1634	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0008 mm. — Weighted mean +28.4 — Mean +28.4

V_a −25.98
V_d − 0.14
Reduction to Sun −26.12
Radial Velocity + 2.3 km.

η *LEONIS*—B 329 — Measured by F. — Power 18

Ti 29.0100	4344.347	+0.104	.....	4344.451			
S 29.9874	4352.275	.....	+0.088	4351.930	+0.433	+29.8	3
Ti 31.8642	4367.778	+0.061	.....	4367.839			
S 34.0068	4385.940	.....	+0.005	4385.548	+0.397	27.1	3
Ti 34.1306	4387.005	+0.002	.....	4387.007			
Ti 35.0730	4395.168	+0.033	.....	4395.201			

η LEONIS—B 329—*Continued*

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
S 35.1219	4395.594	.....	+0.008	4395.201	+0.401	+27.4	2
Ti 35.6180	Standard	±0.000	.....	4399.935			
S 37.5869	4417.445	.....	−0.038	4416.985	+0.422	28.6	4
Ti 37.6400	4417.923	−0.039	.....	4417.884			
Ti 40.4754	4443.981	−0.005	.....	4443.976			
S 40.5205	4444.404	.....	−0.005	4443.976	+0.423	28.5	1
Ti 42.7869	4465.979	−0.004	.....	4465.975			
Ti 43.0643	4468.666	−0.003	.....	4468.663			
S 43.1058	4469.069	.....	−0.004	4468.663	+0.402	27.0	1
Ti 43.3467	4471.413	−0.005	.....	4471.408			
Ti 44.3683	Standard	±0.000	.....	4481.438			
S 44.4087	4481.837	.....	±0.000	4481.400	+0.437	29.2	4
Ti 45.0789	4488.497	−0.004	.....	4488.493			
S 45.2098	4489.804	.....	−0.003	4489.351	+0.450	30.0	1½
S 45.4307	4492.016	.....	−0.001	4491.570	+0.445	29.7	2
Ti 45.8580	4496.316	+0.002	.....	4496.318			
Ti 46.3649	4501.450	−0.002	.....	4501.448			
S 46.4006	4501.813	.....	−0.002	4501.448	+0.363	24.2	2
S 47.0943	4508.903	.....	+0.004	4508.455	+0.452	30.1	4
Ti 47.4823	4512.899	+0.007	.....	4512.906			
S 47.7765	4515.943	.....	+0.006	4515.508	+0.441	29.3	3
Ti 47.9931	4518.193	+0.005	.....	4518.198			
S 48.2430	4520.798	.....	+0.008	4520.397	+0.409	27.1	3
Ti 48.4501	4522.903	+0.011	.....	4522.974			
S 48.4762	4523.236	.....	+0.011	4522.802	+0.445	29.5	3
Ti 48.8799	4527.478	+0.012	.....	4527.490			
Ti 50.5092	4544.849	+0.015	.....	4544.864			
S 50.9913	4550.069	.....	+0.018	4549.642	+0.445	29.3	3
Ti 51.2246	4552.608	+0.024	.....	4552.632			
Ti 51.5027	4555.646	+0.016	.....	4555.662			
S 51.5804	4556.497	.....	+0.020	4556.063	+0.454	29.9	2½
S 51.8332	4559.272	.....	+0.020	4558.827	+0.465	30.6	2
Ti 52.2543	4563.919	+0.020	.....	4563.939			
S 52.2914	4564.330	.....	+0.020	4563.939	+0.411	27.0	½
Ti 52.9953	4572.166	−0.010	.....	4572.156			
S 53.0317	4572.573	.....	−0.010	4572.156	+0.407	27.7	1
S 54.0862	4584.474	.....	−0.004	4584.018	+0.452	29.6	3
S 54.4682	4588.831	.....	−0.001	4588.381	+0.449	29.3	1
Ti 54.5813	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0011 mm.

Weighted mean +28.8 — Mean +28.6

V_a −25.98

V_d − 0.14

Reduction to Sun −26.12

Radial Velocity + 2.7 km.

η LEONIS—B 333

1902, April 23, G. M. T. 15h 30m — Measured by F.

Hour angle W 1h 40m — Star excellent; comparison excellent. — Power 17

Ti 27.5052	4367.774	+0.065	.....	4367.839			
S 29.6488	4385.944	.....	−0.004	4385.548	+0.392	+26.8	2
Ti 29.7730	4387.012	−0.005	.....	4387.007			
S 30.7751	4395.695	.....	−0.001	4395.201	+0.493	33.6	1
Ti 31.2597	Standard	±0.000	.....	4399.935			
S 33.2344	4417.495	.....	−0.037	4416.985	+0.473	32.1	2
Ti 33.2817	4417.921	−0.037	.....	4417.884			
Ti 38.4304	4465.984	−0.009	.....	4465.975			
S 38.7612	4469.189	.....	−0.018	4468.663	+0.508	34.1	1
Ti 38.9917	4471.431	−0.023	.....	4471.408			
S 39.0668	4472.163	.....	−0.022	4471.676	+0.465	31.2	2
Ti 40.0117	Standard	±0.000	.....	4481.438			
S 40.0542	4481.858	.....	±0.000	4481.400	+0.458	30.6	4

η *LEONIS*—B 333—*Continued*

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 40.7243	4488.514	−0.021	.....	4488.493			
S 40.8501	4489.770	.....	−0.021	4489.351	+0.398	26.6	1
S 41.0762	4492.034	.....	−0.021	4491.570	+0.443	29.6	2
Ti 41.5042	4496.339	−0.021	.....	4496.318			
S 42.7410	4508.927	.....	−0.019	4508.455	+0.453	30.1	3
Ti 43.1292	4512.924	−0.018	.....	4512.906			
S 43.4252	4515.987	.....	−0.013	4515.508	+0.466	31.0	2
Ti 43.6390	4518.207	−0.009	.....	4518.198			
S 43.8952	4520.876	.....	−0.010	4520.397	+0.469	31.1	2
Ti 44.0970	4522.985	−0.011	.....	4522.974			
S 44.1278	4523.308	.....	−0.011	4522.802	+0.495	32.8	2
S 45.9000	4542.106	.....	−0.009	4541.690	+0.407	26.9	1
Ti 46.1565	4544.867	−0.003	.....	4544.864			
S 46.6430	4550.132	.....	+0.002	4549.642	+0.492	32.4	4
Ti 46.8719	4552.623	+0.009	.....	4552.632			
Ti 47.1502	4555.662	±0.000	.....	4555.662			
S 47.2269	4556.501	.....	+0.004	4556.063	+0.442	29.1	2
S 47.4772	4559.248	.....	+0.003	4558.827	+0.424	27.9	3
S 49.7345	4584.485	.....	+0.001	4584.018	+0.468	30.6	4
S 50.1154	4588.828	.....	±0.000	4588.381	+0.447	29.2	1
Ti 50.2288	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0012 mm. Weighted mean +30.4 Mean +30.3

V_a −26.84
V_d − 0.13
Reduction to Sun −26.97
Radial Velocity + 3.4 km.

η *LEONIS*—B 337

1902, April 30, G. M. T. $15^h\ 51^m$ Measured by A.
Hour angle W $2^h\ 28^m$ Star weak; comparison good. Power 18

S 24.9032	4386.014	.....	±0.000	4385.548	+0.466	+31.9	1
Ti 25.0188	Standard	±0.000	.....	4387.007			
S 28.4827	4417.468	.....	−0.031	4416.985	+0.452	30.7	1
Ti 28.5325	4417.916	−0.032	.....	4417.884			
Ti 31.3730	4443.980	−0.004	.....	4443.976			
S 31.4218	4444.437	.....	−0.004	4443.976	+0.457	30.8	1
Ti 35.2720	Standard	±0.000	.....	4481.438			
S 35.3186	4481.898	.....	±0.000	4481.400	+0.498	33.3	1
Ti 36.0611	4489.268	−0.006	.....	4489.262			
S 36.1196	4489.852	.....	−0.006	4489.351	+0.495	33.1	1
S 38.0041	4508.922	.....	−0.008	4508.455	+0.459	30.5	1
Ti 38.3923	4512.914	−0.008	.....	4512.906			
S 38.6883	4515.973	.....	−0.006	4515.508	+0.459	30.5	1
S 39.1644	4520.920	.....	−0.002	4520.397	+0.521	34.6	1
Ti 39.3612	4522.975	−0.001	.....	4522.974			
S 41.1705	4542.141	.....	+0.005	4541.690	+0.456	30.1	1
Ti 41.4232	4544.858	+0.006	.....	4544.864			
Ti 42.4196	4555.669	−0.007	.....	4555.662			
S 42.4204	4555.678	.....	−0.007	4555.162	+0.509	33.5	1
S 42.5113	4556.672	.....	−0.007	4556.202	+0.463	30.5	1
S 44.3449	4577.015	.....	−0.003	4576.512	+0.500	32.8	1
S 44.9205	4583.515	.....	−0.001	4583.011	+0.503	32.9	1
S 45.0117	4584.550	.....	−0.001	4584.018	+0.531	34.7	1
S 45.3939	4588.904	.....	±0.000	4588.381	+0.523	34.2	1
Ti 45.5008	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0008 mm. Weighted mean +32.3 Mean +32.3

V_a −28.06
V_d − 0.20
Reduction to Sun −28.26
Radial Velocity + 4.0 km.

η *LEONIS* — B 337 Measured by F. Power 18

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	k. m.	
Ti 35.1895	Standard	±0.000	.....	4481.438			
S 35.2347	4481.884	.....	±0.000	4481.400	+0.484	+32.4	
Ti 35.9777	4489.256	+0.006	.....	4489.262			
S 36.0391	4489.868	.....	+0.006	4489.351	+0.523	34.9	1
S 36.2548	4492.025	.....	+0.002	4491.570	+0.457	30.5	1½
Ti 36.6840	4496.336	−0.018	.....	4496.318			
Ti 37.4337	4503.928	−0.002	.....	4503.926			
S 37.9226	4508.924	.....	±0.000	4508.455	+0.468	31.1	2
Ti 38.3093	4512.899	+0.007	.....	4512.906			
S 38.6083	4515.989	.....	+0.015	4515.508	+0.500	33.2	1½
Ti 38.8188	4518.171	+0.027	.....	4518.198			
S 39.0818	4520.908	.....	+0.016	4520.397	+0.527	35.0	2
Ti 39.2789	4522.966	+0.008	.....	4522.974			
S 39.3112	4523.303	.....	+0.008	4522.802	+0.509	33.8	3
Ti 39.7103	Standard	±0.000	.....	4527.490			
S 41.0903	4542.155	.....	+0.019	4541.690	+0.484	32.0	1
Ti 41.3402	4544.841	+0.023	.....	4544.864			
S 41.8295	4550.152	.....	+0.021	4549.642	+0.510	33.6	1
Ti 42.0578	4552.613	+0.019	.....	4552.632			
Ti 42.3373	4555.662	±0.000	.....	4555.662			
S 42.4250	4556.621	.....	+0.001	4556.063	+0.559	36.8	2
S 42.6712	4559.321	.....	+0.004	4558.827	+0.498	32.8	1
Ti 42.7418	4560.097	+0.005	.....	4560.102			
S 44.9304	4584.562	.....	+0.001	4584.018	+0.545	35.6	2½
S 45.3072	4588.855	.....	±0.000	4588.381	+0.474	31.0	1
Ti 45.4183	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0009 mm. Weighted mean +33.5 Mean +33.3

V_a −28.06
V_d − 0.20
Reduction to Sun −28.26
Radial Velocity + 5.2 km.

SUMMARY OF MEASURES OF η *LEONIS*

Plate	Date	Adams	No. of Lines	Frost	No. of Lines
B 329	1902, April 19	+2.3	11	+2.7	21
B 333	April 23	.....	..	+3.4	18
B 337	April 30	+4.1	15	+5.2	13
	Mean	+3.2		+3.7	

Mean of 3 plates +3.5 km.
Mean of all measures +3.5 km.

13. γ *CORVI*

(R. A. = $12^h\ 11^m$; Dec. = −16° 59′; Mag. 2.8; Class VIa)

Three plates of this star have been measured by each observer. The spectrum shows numerous very faint and broad metallic lines which are not adapted to accurate measurement. The *Mg* line λ 4481 is decidedly the best line in the spectrum.

γ *CORVI*—B 305

1902, April 2, G. M. T. $16^h\,32^m$ — Measured by A.
Hour angle E $0^h\,46^m$ — Star fair; comparison good. — Power 17

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 18.6801	Standard	±0.000	.....	4338.084			
S 18.9779	4340.465	.....	±0.000	4340.634	−0.169	−11.7	1
S 30.9092	4443.870	.....	±0.000	4443.976	−0.106	7.2	1
Ti 30.9205	Standard	±0.000	.....	4443.976			
S 33.4950	4468.551	.....	−0.002	4468.663	−0.114	7.6	1
Ti 33.5067	4468.665	−0.002	.....	4468.663			
S 33.8066	4471.586	.....	−0.002	4471.676	−0.092	6.2	2
S 34.7998	4481.346	.....	−0.002	4481.400	−0.056	3.8	2
Ti 34.8093	4481.440	−0.002	.....	4481.438			
S 36.7853	4501.275	.....	+0.012	4501.445	−0.158	10.5	1
Ti 36.8008	4501.433	+0.012	.....	4501.445			
S 42.6707	4563.813	.....	±0.000	4563.939	−0.126	8.3	2
Ti 42.6820	Standard	±0.000	.....	4563.939			
S 43.4095	4572.054	.....	−0.038	4572.156	−0.140	9.2	2
Ti 43.4220	4572.194	−0.038	.....	4572.156			

Curvature Cor. +0.0008 mm. — Weighted mean −7.7 — Mean −8.0

V_a − 1.09
V_d + 0.06

Reduction to Sun − 1.03
Radial Velocity − 8.7 km.

γ *CORVI*—B 305 — Measured by F. Power 12

S 29.7935	4367.724	.....	±0.000	4367.775	−0.051	−3.5	1
Ti 29.8072	Standard	±0.000	.....	4367.839			
Ti 40.9955	4468.675	−0.012	.....	4468.663			
S 40.9987	4468.705	.....	−0.012	4468.663	+0.030	+ 2.0	1
S 41.0797	4469.494	.....	−0.014	4469.545	−0.065	− 4.4	2
Ti 41.2785	4471.430	−0.022	.....	4471.408			
S 41.3004	4471.644	.....	−0.022	4471.676	−0.054	− 3.6	1
S 42.2890	4481.356	.....	±0.000	4481.400	−0.044	− 2.9	3
Ti 42.2973	Standard	±0.000	.....	4481.438			
Ti 44.2900	4501.432	+0.013	.....	4501.445			
S 44.2935	4501.468	.....	+0.013	4501.445	+0.036	+ 2.4	1
Ti 45.9164	4518.177	+0.021	.....	4518.198			
S 45.9395	4518.418	.....	+0.021	4518.506	−0.067	− 4.4	1
Ti 48.8054	4548.909	+0.029	.....	4548.938			
S 48.8760	4549.677	.....	+0.029	4549.767	−0.061	− 4.0	2
S 50.1583	4563.758	.....	+0.020	4563.939	−0.161	−10.6	3
Ti 50.1730	4563.919	+0.020	.....	4563.939			
Ti 52.4960	Standard	±0.000	.....	4590.126			

Weighted mean −4.3 — Mean −3.2
Curvature Cor. −0.81

V_a −1.09
V_d +0.06

Reduction to Sun −1.03
Radial Velocity −6.2 km.

γ CORVI—B 312

1902, April 3, G. M. T. 16h 32m — Measured by A.
Hour angle E 0h 47m — Star rather weak; comparison good. — Power 17

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 21.3728	Standard	±0.000	.....	4338.084			
S 21.6969	4340.594	.....	±0.000	4340.634	−0.040	− 2.8	1
Ti 33.6225	4443.967	+0.006	.....	4443.976			
S 36.2051	4468.600	.....	±0.000	4468.663	−0.063	4.2	1
Ti 36.2116	Standard	±0.000	.....	4468.663			
S 37.5026	4481.313	.....	+0.018	4481.400	−0.069	4.6	4
Ti 37.5134	4481.420	+0.018	.....	4481.438			
S 42.6364	4533.978	.....	+0.027	4534.139	−0.134	8.9	2
Ti 42.6490	4534.112	+0.027	.....	4534.139			
S 45.3798	4563.772	.....	+0.031	4563.939	−0.136	8.9	1
Ti 45.3921	4563.908	+0.031	.....	4563.939			
S 46.1206	4572.027	.....	+0.017	4572.156	−0.112	7.3	2
Ti 46.1306	4572.139	+0.017	.....	4572.156			
Ti 47.7164	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0008 mm. — Weighted mean −6.1 — Mean −6.1

V_a − 1.59
V_d + 0.07

Reduction to Sun −1.52
Radial Velocity −7.6 km.

γ CORVI—B 312

Measured by F.
Power 12

S 29.4604	4395.183	.....	+0.012	4395.286	−0.091	− 6.2	1
Ti 29.4610	4395.189	+0.012	.....	4395.201			
Ti 30.0034	Standard	±0.000	.....	4399.935			
Ti 33.0540	4427.274	−0.008	.....	4427.266			
S 33.0690	4427.411	.....	−0.008	4427.420	−0.017	− 1.2	1
Ti 34.8571	4443.967	+0.009	.....	4443.976			
S 34.8623	4444.016	.....	+0.009	4443.976	+0.049	+ 3.3	1
Ti 37.4455	4468.661	+0.002	.....	4468.663			
S 37.4480	4468.685	.....	+0.002	4468.663	+0.024	+ 1.6	1
S 38.7417	4481.364	.....	±0.000	4481.400	−0.036	− 2.4	3
Ti 38.7492	Standard	±0.000	.....	4481.438			
Ti 40.7438	4501.444	+0.001	.....	4501.445			
S 40.7570	4501.577	.....	+0.001	4501.445	+0.133	+ 8.9	2
Ti 45.2619	4548.923	+0.015	.....	4548.938			
S 45.3278	4549.639	.....	+0.019	4549.767	−0.109	− 7.2	2
S 45.5914	4552.509	.....	+0.029	4552.663	−0.125	− 8.2	1
Ti 45.6000	4552.603	+0.029	.....	4552.632			
S 46.6158	4563.770	.....	+0.023	4563.939	−0.146	− 9.6	1
Ti 46.6290	4563.916	+0.023	.....	4563.939			
S 47.3605	4572.064	.....	+0.016	4572.156	−0.076	− 5.0	1
Ti 47.3673	4572.140	+0.016	.....	4572.156			
S 48.4139	4583.955	+0.006	.....	4584.018	−0.057	− 3.7	1
Ti 48.9541	Standard	±0.000	.....	4590.126			

Weighted mean −3.9 — Mean − 4.2
Curvature Cor. −0.87

V_a −1.59
V_d +0.07

Reduction to Sun −1.52
Radial Velocity −6.3 km.

1902, April 19, G. M. T. 17h 3m
Hour angle W 0h 45m

*γ CORVI—B 330

Star good; comparison good.

Measured by A.
Power 17

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
S 36.4469	4468.620	.....	±0.000	4468.663	−0.043	− 2.9	1
Ti 36.4513	Standard	±0.000	.....	4468.663			
S 37.7570	4481.457	.....	+0.003	4481.400	+0.060	+ 4.9	2
Ti 37.7547	4481.435	+0.003	.....	4481.438			
S 39.7493	4501.436	.....	±0.000	4501.445	−0.009	− 0.6	1
Ti 39.7504	Standard	±0.000	.....	4501.445			
S 42.8979	4534.185	.....	−0.011	4534.139	+0.035	+ 2.3	1
Ti 42.9711	4534.964	−0.011	.....	4534.953			
S 45.6353	4563.896	.....	−0.002	4563.939	−0.045	− 3.0	1
Ti 45.6394	4563.941	−0.002	.....	4563.939			
S 46.3747	4572.128	.....	±0.000	4572.156	−0.028	− 1.8	1
Ti 46.3772	Standard	±0.000	.....	4572.156			

Curvature Cor. +0.0008 mm.

Weighted mean +0.3 Mean −0.3

V_a −9.29
V_d −0.06

Reduction to Sun −9.35
Radial Velocity −9.1 km.

γ CORVI—B 330

Measured by F.
Power 12

Ti 30.0032	Standard	±0.000	.....	4427.266			
S 30.0313	4427.523	.....	±0.000	4427.420	+0.103	+7.0	1
Ti 34.4000	4468.667	−0.004	.....	4468.663			
S 34.4075	4468.739	.....	−0.004	4468.663	+0.072	4.8	½
S 34.7232	4471.810	.....	−0.003	4471.676	+0.131	8.8	½
Ti 35.7043	4481.439	−0.001	.....	4481.438			
S 35.7095	4481.490	.....	−0.001	4481.400	+0.089	6.0	3
Ti 37.7005	Standard	±0.000	.....	4501.445			
S 37.7117	4501.558	.....	±0.000	4501.445	+0.113	7.5	1
Ti 38.8196	4512.911	+0.001	.....	4512.912			
Ti 42.2250	4548.961	−0.023	.....	4548.938			
S 42.3124	4549.910	.....	−0.015	4549.767	+0.128	8.4	1
Ti 42.5618	4552.625	+0.007	.....	4552.632			
Ti 43.5924	4563.950	−0.011	.....	4563.939			
S 43.5995	4564.028	.....	−0.011	4563.939	+0.078	5.1	1
Ti 44.3295	Standard	±0.000	.....	4572.156			
S 44.3304	4572.166	.....	±0.000	4572.156	+0.010	0.7	1

Weighted mean +5.9 Mean +6.0
Curvature Cor. −0.86

V_a −9.29
V_d −0.06

Reduction to Sun −9.35
Radial Velocity −4.3 km.

SUMMARY OF MEASURES OF γ CORVI

Plate	Date	Adams	No. of Lines	Frost	No. of Lines
B 305	1902, April 2	−8.7	8	−6.2	9
B 312	April 3	−7.6	6	−6.3	10
B 330	April 19	−9.1	6	−4.3	8
Mean		−8.4		− 5.5	

Mean of 3 plates − 7.0 km.
Mean of all measures − 7.0 km.

14. τ *HERCULIS*

(R. A.= 16h 17m; Dec.= +46° 33′; Mag. 3.9; Class V*a*)

Four plates of this star have been measured, four by A., and two by F. The spectrum is very similar to that of *β Orionis*, the lines being rather broad but fairly well defined.

1902, February 19, G. M. T. 21h 33m — τ *HERCULIS*—A 325 — Measured by A.
Hour angle E 2h 33m — Star good; comparison good. — Power 20

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 21.1914	Standard	±0.000	.....	4338.084			
S 21.3945	4340.276	.....	±0.000	4340.634	−0.358	−24.7	2
S 25.6210	4387.718	.....	±0.000	4388.100	−0.382	26.1	2
Ti 26.2596	Standard	±0.000	.....	4395.201			
Ti 32.1604	4468.667	−0.004	.....	4468.663			
S 32.3572	4471.260	.....	−0.003	4471.676	−0.419	28.1	4
S 33.0975	4481.103	.....	±0.000	4481.400	−0.297	19.9	2
Ti 33.1225	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0005 mm. Weighted mean −25.4 Mean −24.7

V_a +11.77
V_d + 0.15

Reduction to Sun +11.92
Radial Velocity −13.5 km.

1902, March 12, G. M. T. 22h 9m — τ *HERCULIS*—B 295 — Measured by A.
Hour angle E 0h 45m — Star good; comparison good. — Power 21

Ti 21.2628	Standard	±0.000	.....	4338.084			
S 21.5507	4340.383	.....	±0.000	4340.634	−0.253	−17.5	1
Ti 27.1712	4387.026	−0.019	.....	4387.007			
S 27.2620	4387.808	.....	−0.018	4388.100	−0.310	21.2	2
Ti 28.6561	Standard	±0.000	.....	4399.935			
Ti 36.0928	4468.650	+0.013	.....	4468.663			
S 36.3713	4471.363	.....	+0.010	4471.676	−0.303	20.3	3
S 37.3580	4481.064	.....	±0.000	4481.400	−0.336	22.5	4
Ti 37.3958	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0009 mm. Weighted mean −21.1 Mean −20.4

V_a + 9.65
V_d + 0.05

Reduction to Sun + 9.70
Radial Velocity −11.4 km.

1902, March 13, G. M. T. 19h 36m — τ *HERCULIS*—B 301 — Measured by A.
Hour angle E 3h 12m — Star slightly weak; comparison good. — Power 20

Ti 29.1733	Standard	±0.000	.....	4399.935			
S 33.3328	4437.460	.....	±0.000	4437.718	−0.258	−17.4	1
Ti 34.0320	Standard	±0.000	.....	4443.976			
Ti 36.6224	4468.668	−0.005	.....	4468.663			
S 36.9031	4471.397	.....	−0.004	4471.676	−0.283	19.0	3
S 37.8874	4481.051	.....	±0.000	4481.400	−0.349	23.4	3
Ti 37.9266	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0008 mm. Weighted mean −20.6 Mean −19.9

V_a +9.53
V_d +0.17

Reduction to Sun + 9.70
Radial Velocity −10.9 km.

τ *HERCULIS*—B 301

Measured by F.
Power 14

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 36.1373	Standard	±0.000	.....	4465.975			
S 36.6877	4471.332	.....	+0.003	4471.676	−0.341	−22.9	1
Ti 36.6951	4471.405	+0.003	.....	4471.408			
S 37.6728	4481.014	.....	±0.000	4481.400	−0.386	−25.8	1
Ti 37.7157	Standard	±0.000	.....	4481.438			
Ti 38.4255	Standard	±0.000	.....	4488.493			

Curvature Cor. +0.0013 mm.

Weighted mean −24.4 Mean −24.4

V_a +9.53
V_d +0.17

Reduction to Sun + 9.70

Radial Velocity −14.7 km.

τ *HERCULIS*—B 313

1902, April 3, G. M. T. $17^h\ 29^m$
Hour angle E $3^h\ 58^m$

Star weak; comparison fair.

Measured by A.
Power 17

Ti 21.1901	Standard	±0.000	.....	4338.084			
S 21.4742	4340.354	.....	−0.001	4340.634	−0.281	−19.4	1
S 27.2043	4387.939	.....	−0.026	4388.100	−0.187	12.8	1
Ti 28.0459	4395.231	−0.030	.....	4395.201			
S 32.7402	4437.439	.....	−0.004	4437.718	−0.283	19.1	2
Ti 33.4414	Standard	±0.000	.....	4443.976			
Ti 36.0305	4468.668	−0.005	.....	4468.663			
S 36.3129	4471.415	.....	−0.002	4471.676	−0.263	17.6	3
S 37.2987	4481.091	.....	+0.012	4481.400	−0.297	20.0	4
Ti 37.3326	4481.426	+0.012	.....	4481.438			
Ti 45.2153	Standard	±0.000	.....	4563.939			

Curvature Cor. + 0.0008 mm.

Weighted mean −18.5 Mean −17.8

V_a +6.17
V_d +0.20

Reduction to Sun + 6.37

Radial Velocity −12.1 km.

τ *HERCULIS*—B 313

Measured by F.
Power 12

Ti 39.1607	Standard	±0.000	.....	4468.663			
S 39.4455	4471.439	.....	±0.000	4471.676	−0.237	−15.9	1
S 40.4213	4481.032	.....	±0.000	4481.400	−0.368	−24.6	1
Ti 40.4623	Standard	±0.000	.....	4481.438			
Ti 48.3471	4563.949	−0.010	.....	4563.939			
Ti 49.0852	Standard	±0.000	.....	4572.156			

Curvature Cor. + 0.0013 mm.

Weighted mean −20.3 Mean −20.3

V_a +6.17
V_d +0.20

Reduction to Sun + 6.37

Radial Velocity −13.9 km.

SUMMARY OF MEASURES OF τ *HERCULIS*

Plate	Date	Adams	No. of Lines	Frost	No. of Lines
A 325	1902, Feb. 19	−13.5	4	.....	..
B 295	Mar. 12	−11.4	4	.....	..
B 301	Mar. 13	−10.9	3	−14.7	2
B 313	April 3	−12.1	5	−13.9	2
	Mean	−12.0		−14.3	

Mean of 4 plates −12.7 km.
Mean of all measures −12.7 km.

15. ζ *DRACONIS*

(R. A. = 17h 7m; Dec. = +65° 50′; Mag. 3.3; Class V*a*)

Four plates of this star have been measured, by each observer. The spectrum contains few lines, but these, though rather broad, are better defined than in most of the stars containing them.

ζ *DRACONIS*—B 290

1902, February 3, G. M. T. 22h 24m
Hour angle E 3h 42m
Star good; comparison rather weak.
Measured by A.
Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 20.6686	Standard	±0.000	.....	4338.084			
S 20.9577	4340.406	.....	±0.000	4340.634	−0.228	−15.8	1
S 22.3687	4351.863	.....	±0.000	4352.083	−0.220	15.2	1
Ti 28.0210	Standard	±0.000	.....	4399.935			
S 29.9143	4416.863	.....	−0.003	4417.121	−0.261	17.7	1
Ti 30.0273	4417.887	−0.003	.....	4417.884			
Ti 35.4213	4468.674	−0.011	.....	4468.663			
S 35.7115	4471.517	.....	−0.008	4471.676	−0.167	11.2	1
S 36.6858	4481.146	.....	±0.000	4481.400	−0.254	17.0	3
Ti 36.7152	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0008 mm.
Weighted mean −15.8
Mean −15.4
V_a + 2.03
V_d + 0.12
Reduction to Sun + 2.15
Radial Velocity −13.7 km.

ζ *DRACONIS*—B 290

Measured by F.
Power 12

Ti 35.0010	Standard	±0.000	.....	4338.084			
S 35.3010	4340.496	.....	−0.001	4340.634	−0.139	− 9.6	2
Ti 42.3535	Standard	±0.000	.....	4399.935			
Ti 49.7540	4468.659	+0.004	.....	4468.663			
S 50.0357	4471.417	.....	+0.003	4471.676	−0.256	17.2	2
S 51.0140	4481.080	.....	±0.000	4481.400	−0.323	21.4	3
Ti 51.0500	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0010 mm.
Weighted mean −16.5
Mean −16.1
V_a +2.03
V_d +0.12
Reduction to Sun + 2.15
Radial Velocity −14.4

ξ DRACONIS — A 314

1902, February 10, G. M. T. 22h 12m
Hour angle E 3h 24m

Star good; comparison good.

Measured by A.
Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 21.4626	Standard	±0.000	.....	4338.084			
S 21.6748	4340.375	.....	±0.000	4340.634	−0.259	−17.9	3
Ti 25.8323	4387.016	−0.009	.....	4387.007			
S 25.9032	4387.842	.....	−0.009	4388.100	−0.267	18.2	2
Ti 26.9314	Standard	±0.000	.....	4399.935			
Ti 32.4327	4468.671	−0.008	.....	4468.663			
S 32.6389	4471.388	.....	−0.006	4471.676	−0.294	19.7	3
S 33.3751	4481.177	.....	±0.000	4481.400	−0.223	14.9	3
Ti 33.3946	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0005 mm.

Weighted mean −17.7 Mean −17.7

V_a + 1.79
V_d + 0.11

Reduction to Sun + 1.90
Radial Velocity −15.8 km.

ξ DRACONIS — A 314

Measured by F.
Power 12

Ti 34.9934	Standard	±0.000	.....	4338.084			
S 35.2065	4340.365	.....	±0.000	4340.644	−0.269	−18.6	2
Ti 39.3611	4387.004	+0.003	.....	4387.007			
S 39.4230	4387.717	.....	+0.003	4388.100	−0.380	26.0	½
Ti 40.4611	Standard	±0.000	.....	4399.935			
Ti 45.7584	4466.003	+0.028	.....	4465.975			
S 46.1762	4471.499	.....	+0.018	4471.676	−0.159	10.7	2
S 46.9095	4481.252	.....	±0.000	4481.400	−0.148	9.9	2
Ti 46.9234	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0009 mm.

Weighted mean −14.0 Mean −16.3

V_a + 1.79
V_d + 0.11

Reduction to Sun + 1.90
Radial Velocity −12.2 km.

ξ DRACONIS — A 324

1901, February 19, G. M. T. 20h 33m
Hour angle E 4h 33m

Star good; comparison good.

Measured by A.
Power 21

Ti 22.5708	Standard	±0.000	.....	4338.084			
S 22.7874	4340.422	.....	−0.001	4340.634	−0.213	−14.7	3
Ti 26.9425	4387.027	−0.020	.....	4387.007			
S 27.0189	4387.916	.....	−0.020	4388.100	−0.204	13.9	1
Ti 28.0410	Standard	±0.000	.....	4399.935			
Ti 33.5441	4468.669	−0.006	.....	4468.663			
S 33.7545	4471.441	.....	−0.005	4471.676	−0.240	16.1	4
S 34.4909	4481.229	.....	±0.000	4481.400	−0.171	11.4	1
Ti 34.5065	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0005 mm.

Weighted Mean −14.9 Mean −14.0

V_a +1.44
V_d +0.13

Reduction to Sun + 1.57
Radial Velocity −13.3 km.

ζ DRACONIS — A 324

Measured by F.
Power 12

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m	t. m.	t. m.	t. m.	km.	
Ti 34.9984	Standard	±0.000	.....	4338.084			
S 35.2102	4340.370	.....	±0.000	4340.634	−0.264	−18.2	2
Ti 40.4686	Standard	±0.000	.....	4399.935			
Ti 45.9704	4468.670	−0.007	.....	4468.663			
S 46.1808	4471.442	.....	−0.006	4471.676	−0.240	16.1	1½
S 46.9135	4481.185	.....	±0.000	4481.400	−0.215	14.4	2
Ti 46.9324	Standard	±0.000	.....	4181.438			

Curvature Cor. +0.0009 mm. Weighted mean −16.2 Mean −16.2

V_a +1.44
V_d +0.13

Reduction to Sun + 1.60
Radial Velocity −14.6 km.

ζ DRACONIS — B 357

1902, May 30, G. M. T. 16h 4m
Hour angle E 2h 27m

Star fair; comparison good.

Measured by A
Power 21

Ti 21.2294	Standard	±0.000	.....	4338.084			
S 21.5206	4340.400	.....	±0.000	4340.634	−0.234	−16.2	1
S 22.9485	4351.878	.....	−0.002	4352.083	−0.207	14.3	1
Ti 24.8920	4367.843	−0.004	.....	4367.839			
Ti 28.6561	Standard	±0.000	.....	4399.935			
S 30.5791	4416.957	.....	−0.025	4417.121	−0.189	12.8	2
Ti 30.6853	4417.910	−0.026	.....	4417.884			
Ti 36.1318	4468.674	−0.011	.....	4468.663			
S 36.4205	4471.476	.....	−0.008	4471.676	−0.208	14.0	3
S 37.4134	4481.186	.....	±0.000	4481.400	−0.214	14.3	2
Ti 37.4390	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0008 mm. Weighted mean −14.0 Mean −14.3

V_a −2.46
V_d +0.09

Reduction to Sun − 2.37
Radial Velocity −16.4 km.

ζ DRACONIS — B 357

Measured by F.
Power 12

Ti 35.0914	Standard	±0.000	.....	4438.084			
S 35.3767	4340.352	.....	+0.004	4340.634	−0.280	−19.3	2
Ti 35.8884	4344.439	+0.012	.....	4344.451			
Ti 41.0274	4387.020	−0.013	.....	4387.007			
S 41.1552	4388.117	.....	−0.012	4388.100	+0.005	+3.4	1
Ti 42.5201	Standard	±0.000	.....	4499.935			
Ti 49.7164	4465.982	+0.007	.....	4465.975			
S 50.2872	4471.507	.....	+0.004	4471.676	−0.167	−11.2	3
S 51.2750	4481.173	.....	±0.000	4481.400	−0.227	−15.2	3
Ti 51.3019	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0009 mm. Weighted mean −12.7 Mean −10.6

V_a +2.46
V_d +0.09

Reduction to Sun − 2.37
Radial Velocity −15.1 km.

SUMMARY OF MEASURES OF ζ *DRACONIS*

Plate	Date	Adams	No. of Lines	Frost	No. of Lines
B 290	1902, Feb. 3	−13.7	5	−14.4	3
A 314	Feb. 10	−15.8	4	−12.2	4
A 324	Feb. 19	−13.3	4	−14.6	3
B 357	May 30	−16.4	5	−15.1	4
	Mean	−14.8		−14.1	

Mean of 4 plates −14.4 km.
Mean of all measures −14.4 km.

16. ι *HERCULIS*

(R. A. = 17h 37m; Dec. = +46°4′; Mag. 3.9; Class IV *b*)

Four plates of this star have been measured, two by F., and four by A. The spectrum contains few lines, but these are well defined, and suitable for fairly accurate measurement.

1901, September 27, G. M. T. 14h 35m — ι *HERCULIS*—A 251 — Measured by A.
Hour angle W 3h 30m — Star good; comparison strong. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 26.5330	4386.994	+0.013	.....	4387.007			
S 26.6174	4387.961	.....	+0.012	4388.100	−0.127	−8.7	1
Ti 27.6518	Standard	±0.000	.....	4399.935			
S 30.7860	4437.582	.....	+0.012	4437.718	−0.124	8.4	1
Ti 31.3001	4443.962	+0.014	.....	4443.976			
Ti 33.0377	4465.975	±0.000	.....	4465.975			
S 33.4709	4471.573	.....	±0.000	4471.676	−0.103	6.9	3
S 34.2137	4481.277	.....	±0.000	4481.400	−0.123	8.2	4
Ti 34.2259	Standard	±0.000	.....	4481.438			
S 39.3722	4552.574	.....	+0.044	4552.750	−0.132	8.7	1
Ti 39.3732	4552.588	+0.044	.....	4552.632			
Ti 40.1497	4563.950	−0.011	.....	4563.939			
S 40.4149	4567.871	.....	−0.010	4567.950	−0.089	5.8	2
Ti 41.8944	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0001 mm. — Weighted mean − 7.6 — Mean −7.8

V_a −10.06
V_d − 0.19
Reduction to Sun −10.25
Radial Velocity −17.8 km.

1901, October 3, G. M. T. 15h 30m — ι *HERCULIS*—A 260 — Measured by A.
Hour angle W 4h 45m — Star good; comparison fair. — Power 21

Ti 17.2714	4387.020	−0.013	.....	4387.007			
S 17.3544	4387.974	.....	−0.012	4388.100	−0.138	−9.4	1
Ti 18.3849	Standard	±0.000	.....	4399.935			
Ti 20.6754	4427.319	−0.053	.....	4427.266			
S 21.5156	4437.651	.....	−0.043	4437.718	−0.110	7.4	1
S 24.1877	4471.587	.....	−0.009	4471.676	−0.098	6.6	2
S 24.9277	4481.286	.....	±0.000	4481.400	−0.114	7.6	2
Ti 24.9392	Standard	±0.000	.....	4481.438			
Ti 30.0724	4552.642	−0.010	.....	4552.632			
S 30.0713	4552.616	.....	−0.010	4552.750	−0.134	8.8	1
Ti 30.2792	Standard	±0.000	.....	4555.662			

Curvature Cor. +0.0001 mm. — Weighted mean −7.8 — Mean −8.0

V_a − 9.71
V_d − 0.22
Reduction to Sun − 9.93
Radial Velocity −17.7 km.

1 HERCULIS—A 260

Measured by F.
Power 12

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 30.0003	Standard	±0.000	.....	4338.084			
S 30.2409	4340.645	.....	−0.001	4340.634	+0.010	+0.7	1
Ti 34.4350	4387.038	−0.031	.....	4387.007			
S 34.5245	4388.065	.....	−0.030	4388.100	−0.065	−4.4	3
Ti 35.5491	4399.945	−0.010	.....	4399.935			
Ti 37.8363	Standard	±0.000	.....	4427.266			
S 38.6818	4437.656	.....	+0.009	4437.718	−0.053	−3.6	2
Ti 39.1885	4443.961	+0.015	.....	4443.976			
Ti 40.9215	4465.976	−0.001	.....	4465.975			
S 41.3537	4471.579	.....	+0.006	4471.676	−0.091	−6.1	4
S 42.0920	4481.255	.....	+0.019	4481.400	−0.126	−8.4	4
Ti 42.1044	4481.419	+0.019	.....	4481.438			
Ti 47.4434	Standard	±0.000	.....	4555.662			

Weighted mean − 5.6 Mean −4.4
Curvature Cor. − 0.27
V_a −9.71
V_d −0.22
Reduction to Sun − 9.93
Radial Velocity −15.8 km.

1 HERCULIS—B 203

1901, October 18, G. M. T. 15h 27m
Hour angle W 5h 42m

Star weak; comparison strong.

Measured by A.
Power 24

Ti 40.3344	Standard	±0.000	.....	4468.663			
S 40.6336	4471.547	.....	+0.001	4471.676	−0.128	−8.6	1
S 41.6345	4481.279	.....	+0.005	4481.400	−0.116	7.8	2
Ti 41.6502	4481.433	+0.005	.....	4481.438			
Ti 44.7949	4512.903	+0.003	.....	4512.906			
Ti 48.5741	4552.617	+0.015	.....	4552.632			
S 48.5752	4552.629	.....	+0.015	4552.750	−0.106	7.0	2
Ti 51.9644	Standard	±0.000	.....	4590.126			
Ti 61.7980	Standard	±0.000	.....	4710.368			
S 62.0145	4713.227	.....	±0.000	4713.308	−0.081	5.2	3

Curvature Cor. +0.0002 mm.

Weighted mean − 6.7 Mean −7.1
V_a −8.39
V_d −0.24
Reduction to Sun − 8.63
Radial Velocity −15.3 km.

1 HERCULIS—B 203

Measured by F.
Power 12

Ti 34.9975	4386.971	+0.036	.....	4387.007			
S 35.1125	4387.952	.....	+0.033	4388.100	−0.115	− 7.9	2
Ti 36.5035	Standard	±0.000	.....	4399.935			
Ti 37.7940	4411.248	−0.008	.....	4411.240			
S 38.2090	4414.927	.....	−0.009	4415.076	−0.158	10.7	½
Ti 43.7450	4465.999	−0.024	.....	4465.975			
S 44.3230	4471.555	.....	−0.015	4471.676	−0.136	9.1	3
S 45.3240	4481.282	.....	±0.000	4481.400	−0.118	7.9	4
Ti 45.3400	Standard	±0.000	.....	4481.438			

HERCULIS—B 203—*Continued*

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 52.2650	4552.612	+0.020	.....	4552.632			
S 52.2660	4552.622	.....	+0.020	4552.750	−0.108	−7.1	2
Ti 55.6550	Standard	±0.000	.....	4590.126			
Ti 61.2750	4656.666	−0.022	.....	4656.644			
Ti 65.4895	4710.502	−0.134	.....	4710.368			
S 65.7060	4713.366	.....	−0.146	4713.308	−0.088	5.6	3

Weighted mean − 7.6 Mean −8.0
Curvature Cor. − 0.18
V_a −8.39
V_d −0.24
Reduction to Sun − 8.63
Radial Velocity −16.4 km.

HERCULIS—B 403

1902, September 3, G. M. T. 17h 20m Measured by A.
Hour angle W 4h 38m Star good; comparison good. Power 17

Ti 20.9299	Standard	±0.000	.....	4338.084			
S 21.2447	4340.589	.....	−0.002	4340.634	−0.047	−3.3	1
Ti 26.8642	4387.044	−0.037	.....	4387.007			
S 26.9867	4388.095	.....	−0.035	4388.100	−0.040	2.7	3
Ti 28.3553	4399.953	−0.018	.....	4399.935			
Ti 31.4156	4427.263	+0.003	.....	4427.266			
S 32.5444	4437.625	.....	+0.002	4437.718	−0.091	6.2	2
Ti 33.7972	Standard	±0.000	.....	4449.313			
Ti 35.8235	4468.651	+0.012	.....	4468.663			
S 36.1231	4471.557	.....	+0.019	4471.676	−0.100	6.7	3
S 37.1156	4481.271	.....	+0.043	4481.400	−0.086	5.8	4
Ti 37.1282	4481.395	+0.043	.....	4481.438			
Ti 44.0047	Standard	±0.000	.....	4552.632			
S 44.0054	4552.640	.....	±0.000	4552.750	−0.110	7.2	3

Curvature Cor. +0.0008 mm.
Weighted mean − 5.5 Mean −5.3
V_a −10.36
V_d − 0.22
Reduction to Sun −10.58
Radial Velocity −16.1 km.

SUMMARY OF MEASURES OF *HERCULIS*

Plate	Date	Adams	No. of Lines	Frost	No. of Lines
A 251	1901, Sept. 27	−17.8	6	.....	..
A 260	Oct. 3	−17.7	5	−15.8	5
B 203	Oct. 18	−15.3	4	−16.4	6
B 403	1902, Sept. 3	−16.1	6	.....	..
Mean		−16.7		−16.1	

Mean of 4 plates −16.6 km.
Mean of all measures −16.4 km.

17. 67 *OPHIUCHI*

(R. A. = 17h 56m; Dec. = +2° 56′; Mag. 4.0; Class Vc)

Three plates of this star have been measured, three by A., and one by F. The lines present in the spectrum are few in number and rather diffuse in character.

67 *OPHIUCHI*—B 347

1902, May 14, G. M. T. 19h 14m — Star weak; comparison strong. — Measured by A.
Hour angle E 1h 7m — Power 17

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 26.5243	Standard	±0.000	.....	4387.007			
S 26.6119	4387.761	.....	±0.000	4388.100	−0.339	−23.2	2
Ti 35.1864	4465.985	−0.010	.....	4465.975			
S 35.7506	4471.458	.....	−0.007	4471.676	−0.225	15.1	2
S 36.7347	4481.107	.....	±0.000	4481.400	−0.293	19.6	1
Ti 36.7682	Standard	±0.000	.....	4481.438			
S 43.6078	4552.378	.....	+0.017	4552.750	−0.355	23.4	2
Ti 43.6295	4552.615	+0.017	.....	4552.632			
S 46.4328	4583.798	.....	±0.000	4584.018	−0.220	14.4	1
Ti 46.9677	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0008 mm. — Weighted mean −19.6 — Mean −19.1

V_a	+15.51
V_d	+ 0.10
Reduction to Sun	+15.61
Radial Velocity	− 4.0 km.

67 *OPHIUCHI*—B 369

1902, June 25, G. M. T. 19h 41m — Star weak; comparison fair. — Measured by A.
Hour angle W 2h 11m — Power 15

Ti 33.5901	Standard	±0.000	.....	4465.975			
S 34.1816	4471.703	.....	±0.000	4471.676	+0.027	+1.8	1
S 35.1712	4481.391	.....	+0.002	4481.400	−0.007	−0.5	3
Ti 35.1757	4481.436	+0.002	.....	4481.438			
Ti 39.2693	Standard	±0.000	.....	4522.974			
Ti 42.0514	4552.621	+0.011	.....	4552.632			
S 42.0588	4552.702	.....	+0.011	4552.750	−0.037	−2.4	2
Ti 45.4160	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0008 mm. — Weighted mean −0.7 — Mean −0.4

V_a	−2.19
V_d	−0.18
Reduction to Sun	−2.37
Radial Velocity	−3.1 km.

67 *OPHIUCHI*—A 346

1902, July 7, G. M. T. $17^h 32^m$
Hour angle W $1^h 45^m$

Star good; comparison good.

Measured by A.
Power 15

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
S 27.0710	4388.094	.....	±0.000	4388.100	−0.006	−0.4	2
Ti 28.0857	Standard	±0.000	.....	4399.935			
Ti 33.6391	4468.668	−0.005	.....	4468.663			
S 33.8791	4471.798	.....	−0.005	4471.676	+0.117	+7.8	3
Ti 34.6120	4481.441	−0.003	.....	4481.438			
S 34.6180	4481.521	.....	−0.003	4481.400	+0.118	+7.9	4
Ti 37.9791	Standard	±0.000	.....	4527.490			
S 41.2400	4575.018	.....	±0.000	4574.900	+0.118	+7.7	1
Ti 47.8867	Standard	±0.000	.....	4682.088			
Ti 49.5012	4710.417	−0.049	.....	4710.368			
S 49.6696	4713.429	.....	−0.049	4713.308	+0.072	+4.6	4

Curvature Cor. +0.0005 mm.

Weighted mean +5.7 — Mean +5.5

V_a −7.38
V_d −0.15

Reduction to Sun −7.53
Radial Velocity −1.8 km.

67 *OPHIUCHI*—A 346

Measured by F. with Zeiss Comparator
Power 13

Ti 32.491	4337.977	+0.107	.....	4338.084			
S 36.978	4388.069	.....	+0.020	4388.100	−0.011	−0.8	2
Ti 37.992	Standard	±0.000	.....	4399.935			
Ti 43.320	4466.002	−0.027	.....	4465.975			
S 43.760	4471.765	.....	−0.017	4471.676	+0.072	+4.8	3
Ti 44.493	Standard	±0.000	.....	4481.438			
S 44.494	4481.451	.....	±0.000	4481.400	+0.051	+3.4	4
Ti 45.600	4496.329	−0.011	.....	4496.318			
Ti 49.587	Standard	±0.000	.....	4552.632			
S 49.594	4552.735	.....	±0.000	4552.750	−0.015	−1.0	½

Weighted mean +2.5 — Mean +1.6
Curvature Cor. +1.41

V_a −7.38
V_d −0.15

Reduction to Sun −7.53
Radial Velocity −3.6 km.

SUMMARY OF MEASURES OF 67 *OPHIUCHI*

Plate	Date	Adams	No. of Lines	Frost	No. of Lines
B 347	1902, May 14	−4.0	5	.....	..
B 369	June 25	−3.1	3	.....	..
A 346	July 7	−1.8	5	−3.6	4
Mean		−3.0		−3.6	

Mean of 3 plates −3.3 km.
Mean of all measures −3.1 km.

18. 102 *HERCULIS*

(R. A. = 18h 4m; Dec. = +20°48′; Mag. 4.5; Class IV*b*)

Four plates of this star have been measured, four by A., and one by F. The lines in the spectrum are diffuse, and not well adapted to accurate measurement.

102 *HERCULIS*—A 358

1902, July 23, G. M. T. 17h 53m — Star good; comparison fair. — Measured by A.
Hour angle W 2h 0m — Power 13

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 21.0616	Standard	±0.000	.....	4338.084			
S 25.5751	4388.053	.....	−0.015	4388.100	−0.062	−4.2	2
Ti 26.1914	4395.218	−0.017	.....	4395.201			
Ti 28.8695	4427.282	−0.016	.....	4427.266			
S 29.7168	4437.754	.....	−0.006	4437.718	+0.030	+2.0	1
Ti 30.2141	Standard	±0.000	.....	4443.976			
Ti 32.1395	4468.613	+0.050	.....	4468.663			
S 32.3669	4471.582	.....	+0.049	4471.676	−0.045	−3.0	2
Ti 38.2196	4552.601	+0.031	.....	4552.632			
S 38.2291	4552.741	.....	+0.031	4552.750	+0.022	+1.4	1
Ti 38.9877	Standard	±0.000	.....	4563.939			
S 39.2607	4568.011	.....	±0.000	4567.950	+0.061	+4.0	1

Curvature Cor. +0.0005 mm. — Weighted mean − 1.0 — Mean 0.0

V_a −10.13
V_d − 0.16

Reduction to Sun −10.29
Radial Velocity −11.3 km.

102 *HERCULIS*—B 385

1902, August 11, G. M. T. 16h 12m — Star good; comparison good. — Measured by A.
Hour angle W 1h 35m — Power 15

Ti 21.1940	Standard	±0.000	.....	4338.084			
Ti 27.1297	4387.052	−0.045	.....	4387.007			
S 27.2596	4388.167	.....	−0.044	4388.100	+0.023	+1.6	1
Ti 28.6223	4399.971	−0.036	.....	4399.935			
S 30.5760	4417.270	.....	−0.029	4417.121	+0.120	8.2	1
Ti 30.6477	4417.913	−0.029	.....	4417.884			
Ti 31.6828	4427.272	−0.006	.....	4427.266			
S 32.8329	4437.825	.....	−0.003	4437.718	+0.104	7.0	1
Ti 34.0647	Standard	±0.000	.....	4449.313			
Ti 36.0938	4468.665	−0.002	.....	4468.663			
S 36.4078	4471.708	.....	−0.002	4471.676	+0.030	2.0	2
S 37.4010	4481.424	.....	−0.001	4481.400	+0.023	1.5	1
Ti 37.4025	4481.439	−0.001	.....	4481.438			
Ti 44.2795	4552.612	+0.020	.....	4552.632			
S 44.2939	4552.770	.....	+0.020	4552.750	+0.040	2.6	2
Ti 45.3132	Standard	±0.000	.....	4563.939			

Curvature Cor. +0.0009 mm. — Weighted mean + 3.5 — Mean +3.8

V_a −15.36
V_d − 0.13

Reduction to Sun −15.49
Radial Velocity −12.0 km.

102 *HERCULIS*—B 385

Measured by F.
Power 13

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 30.0027	4337.991	+0.093	.....	4338.084			
S 30.3396	4340.675	.....	+0.088	4340.634	+0.129	+8.9	1
Ti 35.9388	Standard	±0.000	.....	4387.007			
S 36.0675	4388.112	.....	±0.000	4388.100	+0.012	+0.8	2
Ti 37.4313	4399.933	+0.002	.....	4399.935			
Ti 40.4935	4427.266	±0.000	.....	4327.266			
S 41.6344	4437.739	.....	+0.002	4437.718	+0.023	+1.6	1
Ti 42.8747	4449.309	+0.004	.....	4449.313			
Ti 45.1844	4471.387	+0.021	.....	4471.408			
S 45.2204	4471.736	.....	+0.021	4471.676	+0.081	+5.4	2
Ti 46.2120	Standard	±0.000	.....	4481.438			
S 46.2134	4481.452	.....	±0.000	4481.400	+0.052	+3.5	2
Ti 53.0896	4552.611	+0.021	.....	4552.632			
S 53.1003	4552.727	.....	+0.021	4552.750	−0.002	−0.1	3
Ti 56.4554	Standard	±0.000	.....	4590.126			

Curvature Cor. + 0.0013 mm.

Weighted mean + 2.7 — Mean +3.3

V_a −15.36

V_d − 0.13

Reduction to Sun −15.49

Radial Velocity −12.8 km.

1902, August 27, G. M. T. $15^h\ 0^m$
Hour angle W $1^h\ 28^m$

102 *HERCULIS*—B 397

Star too weak; comparison strong.

Measured by A.
Power 15

Ti 23.4654	4387.005	+0.002	.....	4387.007			
S 23.6159	4388.297	.....	+0.002	4388.100	+0.199	+13.6	2
Ti 24.9590	Standard	±0.000	.....	4399.935			
Ti 28.0223	4427.263	+0.003	.....	4427.266			
Ti 32.4369	4468.681	−0.018	.....	4468.663			
S 32.7593	4471.805	.....	−0.014	4471.676	+0.115	7.7	3
Ti 33.7445	Standard	±0.000	.....	4481.438			
S 33.7507	4481.499	.....	±0.000	4481.400	+0.099	6.6	2
Ti 40.6291	4552.634	−0.002	.....	4552.632			
S 40.6590	4552.937	.....	−0.002	4552.750	+0.185	12.2	2
Ti 41.6619	Standard	±0.000	.....	4563.939			
S 42.0462	4568.189	.....	−0.020	4567.950	+0.219	14.4	1
Ti 42.4064	4572.195	−0.039	.....	4572.156			

Curvature Cor. +0.0009 mm.

Weighted mean +10.3 — Mean +10.9

V_a −18.64

V_d − 0.12

Reduction to Sun −18.76

Radial Velocity − 8.5 km.

1902, September 3, G. M. T. $15^h\ 10^m$
Hour angle W $2^h\ 0^m$

102 *HERCULIS*—B 402

Star rather weak; comparison strong.

Measured by A.
Power 17

Ti 21.1240	Standard	±0.000	.....	4338.084			
Ti 27.0559	4387.056	−0.049	.....	4387.007			
S 27.1998	4388.291	.....	−0.049	4388.100	+0.142	+ 9.7	1
Ti 28.5484	4399.982	−0.047	.....	4399.935			
Ti 29.8296	4411.283	−0.043	.....	4411.240			
S 30.2799	4415.300	.....	−0.043	4415.076	+0.181	12.3	2
Ti 30.5728	4417.927	−0.043	.....	4417.884			
Ti 31.6073	4427.286	−0.020	.....	4427.266			
S 32.7566	4437.839	.....	−0.007	4437.718	+0.114	7.7	2

102 *HERCULIS*—B 402—*Continued*

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 33.4167	4443.975	+0.001	.....	4443.976			
Ti 36.0140	Standard	±0.000	.....	4468.663			
S 36.3404	4471.829	.....	−0.001	4471.676	+0.152	10.2	3
Ti 37.3224	4481.441	−0.003	.....	4481.438			
S 37.3290	4481.506	.....	−0.003	4481.400	+0.103	6.9	2
Ti 44.1950	4552.603	+0.029	.....	4552.632			
S 44.2215	4552.891	.....	+0.029	4552.750	+0.170	11.2	2
Ti 45.2260	4563.905	+0.034	.....	4563.939			
S 45.6067	4568.151	.....	+0.014	4567.950	+0.215	14.1	3
Ti 45.9693	4572.161	−0.005	.....	4572.156			
S 46.2301	4575.079	.....	−0.004	4574.900	+0.175	11.5	2
Ti 47.5587	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0008 mm. Weighted mean +10.6 Mean +10.4

V_a −19.65
V_d − 0.16

Reduction to Sun −19.81
Radial Velocity − 9.2 km.

SUMMARY OF MEASURES OF 102 *HERCULIS*

Plate	Date	Adams	No. of Lines	Frost	No. of Lines
A 358	1902, July 23	−11.3	5	.....	..
B 385	Aug. 11	−12.0	6	−12.8	6
B 397	Aug. 27	− 8.5	5	.....	..
B 402	Sept. 3	− 9.2	8	.....	..
Mean		−10.3		−12.8	

Mean of 4 plates −10.4 km.
Mean of all measures −10.8 km.

19. η *LYRAE*

(R. A. = 19h 10m; Dec. = +38° 58′; Mag. 4.5; Class IV*b*)

Four plates of this star have been measured, four by A., and two by F. The spectrum contains but few lines, and these are not very sharply defined, so that accurate measurement is difficult.

1902, July 31, G. M. T. 20h 51m
Hour angle W 4h 21m

η *LYRAE*—A 365
Star fair; comparison good.

Measured by A.
Power 21

S 27.4920	4388.029	.....	±0.000	4388.100	−0.071	−4.9	1
Ti 28.5143	Standard	±0.000	.....	4399.935			
Ti 30.7921	4427.273	−0.007	.....	4427.266			
S 31.6288	4437.606	.....	−0.004	4437.718	−0.116	7.8	2
Ti 32.5612	Standard	±0.000	.....	4449.313			
Ti 34.0695	4468.691	−0.028	.....	4468.663			
S 34.2915	4471.590	.....	−0.022	4471.676	−0.108	7.2	2
S 35.0255	4481.264	.....	±0.000	4481.400	−0.136	9.1	3
Ti 35.0386	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0005 mm. Weighted mean − 7.8 Mean −7.3

V_a −2.45
V_d −0.24

Reduction to Sun − 2.69
Radial Velocity −10.5 km.

1902, September 13, G. M. T. $17^h\ 57^m$ — η *LYRAE* — B 409 — Measured by A.
Hour angle W $4^h\ 20^m$ — Star weak; comparison good. — Power 15

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 22.4473	4387.014	−0.007	.....	4387.007			
S 22.5690	4388.080	.....	−0.006	4388.100	−0.046	−3.1	2
Ti 23.9362	Standard	±0.000	.....	4399.935			
S 25.8703	4417.103	.....	+0.001	4417.121	−0.017	−1.2	1
Ti 25.9569	4417.883	+0.001	.....	4417.884			
Ti 26.9923	4427.268	−0.002	.....	4427.266			
S 28.1365	4437.793	.....	−0.004	4437.718	+0.071	+4.8	3
Ti 28.8010	4443.981	−0.005	.....	4443.976			
Ti 31.1153	Standard	±0.000	.....	4465.975			
S 31.7046	4471.688	.....	+0.003	4471.676	+0.015	+1.0	3
Ti 32.6982	4481.429	+0.009	.....	4481.438			
S 32.6941	4481.388	.....	+0.009	4481.400	−0.003	−0.2	3
Ti 39.5651	Standard	±0.000	.....	4552.632			
S 39.5829	4552.826	.....	±0.000	4552.750	+0.076	+5.0	1

Curvature Cor. +0.0008 mm. Weighted mean + 1.1 Mean +1.1

V_a −11.51
V_d − 0.24
Reduction to Sun −11.75
Radial Velocity −10.6 km.

1902, October 15, G. M. T. $14^h\ 12^m$ — η *LYRAE* — B 422 — Measured by A.
Hour angle W $2^h\ 45^m$ — Star fair; comparison good. — Power 21

Ti 29.6491	Standard	±0.000	.....	4338.084			
S 29.9775	4340.698	.....	±0.000	4340.634	+0.064	+4.4	1
S 35.7220	4388.258	.....	±0.000	4388.100	+0.158	10.8	2
Ti 36.5256	Standard	±0.000	.....	4395.201			
Ti 40.1270	4427.253	+0.013	.....	4427.266			
S 41.2721	4437.777	.....	+0.009	4437.718	+0.068	4.6	1
Ti 41.9376	4443.969	+0.007	.....	4443.976			
Ti 44.5326	4468.669	−0.006	.....	4468.663			
S 44.8526	4471.778	.....	−0.004	4471.676	+0.098	6.6	1
Ti 45.8379	Standard	±0.000	.....	4481.438			
S 45.8425	4481.483	.....	±0.000	4481.400	+0.083	5.6	3

Curvature Cor. +0.0009 mm. Weighted mean + 6.7 Mean +6.4

V_a −14.54
V_d − 0.17
Reduction to Sun −14.71
Radial Velocity − 8.0 km.

η *LYRAE* — B 422 — Measured by F.
Power 13

Ti 30.0739	Standard	±0.000	.....	4338.084			
S 30.4100	4340.762	.....	−0.002	4340.634	+0.126	+ 8.7	½
S 36.1563	4388.376	.....	−0.036	4388.100	+0.240	16.4	2
Ti 36.9505	4395.241	−0.040	.....	4395.201			
Ti 44.9578	4468.686	−0.023	.....	4468.663			
S 45.2926	4471.936	.....	−0.017	4471.676	+0.243	16.3	3
Ti 46.2628	Standard	±0.000	.....	4481.438			
S 46.2719	4481.528	.....	±0.000	4481.400	+0.128	8.6	3
Ti 54.1648	Standard	±0.000	.....	4563.939			
S 54.5322	4568.011	.....	−0.010	4567.950	+0.051	3.4	1
Ti 54.9059	4572.176	−0.020	.....	4572.156			

Curvature Cor. + 0.0013 mm. Weighted mean +12.1 Mean +10.7

V_a −14.54
V_d − 0.17
Reduction to Sun −14.71
Radial Velocity − 2.6 km.

η *LYRAE*—B 427

1902, October 16, G. M. T. $15^h\ 32^m$ — Measured by A.
Hour angle W $4^h\ 23^m$ — Star weak; comparison good. — Power 21

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 25.6843	4386.989	+0.018	.....	4387.007			
S 25.8232	4388.183	.....	+0.016	4388.100	+0.099	+ 6.8	2
Ti 27.1756	Standard	±0.000	.....	4399.935			
Ti 30.2336	4427.297	−0.031	.....	4427.266			
S 31.3788	4437.837	.....	−0.020	4437.718	+0.099	6.7	2
Ti 32.0390	4443.989	−0.013	.....	4443.976			
Ti 34.6291	4468.668	−0.005	.....	4468.663			
S 35.9322	4481.424	.....	±0.000	4481.400	+0.024	1.6	3
Ti 35.9336	Standard	±0.000	.....	4481.438			
Ti 42.7896	4552.595	+0.037	.....	4552.632			
S 42.8125	4552.845	.....	+0.037	4552.750	+0.132	8.7	1
Ti 43.8220	Standard	±0.000	.....	4563.939			
S 44.1927	4568.055	.....	±0.000	4567.950	+0.105	6.9	2

Curvature Cor. +0.0008 mm. — Weighted mean + 5.4 — Mean +6.1

V_a −14.57
V_d − 0.24
Reduction to Sun −14.81
Radial Velocity − 9.4 km.

η *LYRAE*—B 427 — Measured by F. Power 13

Ti 30.0406	Standard	±0.000	.....	4387.007			
S 30.1635	4388.062	.....	±0.000	4388.100	−0.038	− 2.6	1
Ti 34.5896	Standard	±0.000	.....	4427.266			
S 35.7360	4437.817	.....	−0.003	4437.718	+0.096	+ 6.5	1
Ti 36.9653	4449.320	−0.007	.....	4449.313			
Ti 39.2676	4471.412	−0.004	.....	4471.408			
S 39.3137	4471.861	.....	−0.004	4471.676	+0.181	+12.1	3
Ti 40.2880	Standard	±0.000	.....	4481.438			
S 40.2929	4481.487	.....	±0.000	4481.400	+0.087	+ 5.8	3

Curvature Cor. +0.0013 mm. — Weighted mean + 7.2 — Mean +5.5

V_a −14.57
V_d − 0.24
Reduction to Sun −14.81
Radial Velocity − 7.6 km.

SUMMARY OF MEASURES OF η *LYRAE*

Plate	Date	Adams	No. of Lines	Frost	No. of Lines
A 365	1902, July 31	−10.5	4	.....	..
B 409	Sept. 13	−10.6	6	.....	..
B 422	Oct. 15	− 8.0	5	−2.6	5
B 427	Oct. 16	− 9.4	5	−7.6	4
	Mean	− 9.6		−5.1	

Mean of 4 plates −8.7 km.
Mean of all measures −9.1 km.

20. ϵ *DELPHINI*

(R. A.=$20^h\ 28^m$; Dec.= +10° 58′; Mag. 4.1; Class V*a*)

Four plates of this star have been measured, all of them by A. The spectrum contains very few lines, among them traces of one or two oxygen lines, and all of these are poorly defined.

ϵ *DELPHINI*—A 349

1902, July 11, G. M. T. $17^h\,55^m$ — Measured by A.
Hour angle E $1^h\,11^m$ — Star weak; comparison good. — Power 14

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 20.1815	Standard	±0.000	.....	4338.084			
S 20.3642	4340.037	.....	±0.000	4340.634	−0.597	−41.3	1
Ti 26.0799	Standard	±0.000	.....	4404.433			
S 26.9275	4414.558	.....	−0.001	4415.076	−0.519	35.3	1
Ti 31.2436	4468.666	−0.003	.....	4468.663			
S 31.4346	4471.164	.....	−0.002	4471.676	−0.514	34.5	2
S 32.1652	4480.804	.....	±0.000	4481.400	−0.596	39.9	4
Ti 32.2129	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0005 mm. — Weighted mean −38.2 — Mean −37.7

V_a +10.25
V_d + 0.10
Reduction to Sun +10.35
Radial Velocity −27.8 km.

ϵ *DELPHINI*—A 353

1902, July 16, G. M. T. $18^h\,48^m$ — Measured by A.
Hour angle W $0^h\,5^m$ — Star good; comparison good. — Power 17

Ti 23.8727	Standard	±0.000	.....	4338.084			
S 24.0696	4340.189	.....	±0.000	4340.634	−0.445	−30.8	1
Ti 28.9894	4395.209	−0.008	.....	4395.201			
Ti 29.3926	Standard	±0.000	.....	4399.935			
Ti 34.9402	4468.655	+0.008	.....	4468.663			
S 35.1308	4471.146	.....	+0.006	4471.676	−0.524	35.1	2
S 35.8739	4480.942	.....	±0.000	4481.400	−0.458	30.6	1
Ti 35.9112	Standard	±0.000	.....	4481.438			

Curvature Cor. +0.0005 mm. — Weighted mean −32.9 — Mean −32.2

V_a + 8.22
V_d − 0.01
Reduction to Sun + 8.21
Radial Velocity −24.7 km.

ϵ *DELPHINI*—A 359

1902, July 23, G. M. T. $19^h\,59^m$ — Measured by A.
Hour angle W $1^h\,39^m$ — Star fair; comparison fair. — Power 13

Ti 25.0852	Standard	±0.000	.....	4338.084			
S 25.2773	4340.139	.....	−0.001	4340.634	−0.496	−34.3	2
S 29.5420	4387.590	.....	−0.008	4388.100	−0.518	35.4	1
Ti 30.1979	4395.210	−0.009	.....	4395.201			
Ti 32.8751	Standard	±0.000	.....	4427.266			
Ti 34.2187	4443.956	+0.020	.....	4443.976			
Ti 36.1468	4468.649	+0.014	.....	4468.663			
S 36.3447	4471.233	.....	+0.013	4471.676	−0.430	28.8	1
S 37.0832	4480.970	.....	+0.010	4481.400	−0.420	28.1	2
Ti 37.1176	4481.428	+0.010	.....	4481.438			
Ti 38.6030	Standard	±0.000	.....	4501.445			

Curvature Cor. +0.0005 mm. — Weighted mean −31.5 — Mean −31.6

V_a +5.28
V_d −0.14
Reduction to Sun + 5.14
Radial Velocity −26.4 km.

ε DELPHINI—A 363

1902, July 31, G. M. T. $16^h\ 45^m$ — Measured by A.
Hour angle E $1^h\ 5^m$ — Star slightly weak; comparison good. — Power 13

Mean of Settings	Wave-Length by Formula	Correction to Comp. Lines	Correction to Star Lines	Normal Wave-Length	Displacement	Velocity	Weight
mm.	t. m.	t. m.	t. m.	t. m.	t. m.	km.	
Ti 22.5790	4386.956	+0.051	.....	4387.007			
S 22.6325	4387.574	.....	+0.049	4388.100	−0.477	−32.6	1
Ti 23.6921	Standard	±0.000	.....	4399.935			
S 25.1003	4416.725	.....	−0.018	4417.121	−0.414	28.1	1
Ti 25.1978	4417.903	−0.019	.....	4417.884			
Ti 25.9676	4427.277	−0.011	.....	4427.266			
S 26.7834	4437.355	.....	−0.027	4437.718	−0.390	26.4	1
Ti 27.7398	4449.360	−0.047	.....	4449.313			
Ti 29.2448	4468.683	−0.020	.....	4468.663			
S 29.4421	4471.257	.....	−0.016	4471.676	−0.435	29.2	2
S 30.1842	4481.020	.....	±0.000	4481.400	−0.380	25.4	2
Ti 30.2157	Standard	±0.000	.....	4481.438			
Ti 37.8308	Standard	±0.000	.....	4590.126			

Curvature Cor. +0.0005 mm. — Weighted mean −2.80 — Mean −28.3

V_a +1.91
V_d +0.09

Reduction to Sun + 2.00
Radial Velocity −26.0 km.

SUMMARY OF MEASURES OF *ε DELPHINI*

Plate	Date	Adams	No. of Lines
A 349	1902, July 11	−27.8	4
A 353	July 16	−24.7	3
A 359	July 23	−26.4	4
A 363	July 31	−26.0	5

Mean −26.2 km.
Mean of all measures −26.2 km.

SUMMARY OF RADIAL VELOCITIES

The table which follows gives a summary of the results for the stars which we have considered in this paper. As the final velocity of each star the mean of all the measures has been adopted, so that a plate measured by both observers will have twice as much weight as a plate measured by only one. This procedure has seemed preferable to that of assigning unit weight to each plate without regard to the number of measures made of it, but the difference between the values found in the two ways is in general very slight, as a brief inspection of the summaries given at the end of the detailed measurements of each star at once shows. Column six of the table below accordingly gives the total number of measures for the individual stars, while the following column indicates the epoch to which the final velocity belongs. For comparison a list of the proper motions of the stars is appended, the values of which have been very kindly communicated to us by Professor Lewis Boss, in advance of their publication in his "Catalogue of 627 Principal Standard Stars" in the *Astronomical Journal* (Nos. 531, 532, February, 1903). For the three stars not included in his "Catalogue" (67 *Ophiuchi*, 102 *Herculis*, and *η Lyrae*) Professor Boss was good enough to furnish us with values in systematic conformity therewith. The proper motions correspond to Professor Newcomb's value of the precession.

SUMMARY

Mag.	Star	R. A.	Dec.	Radial Velocity	No. of Measures	Epoch	Proper Motion		
							R. A.	Dec.	Great Circle
				km.					
3.0	*γ Pegasi*	0h 08m	+14° 38′	+ 5.4	12	1902.06	0s.0000	−0″.013	0″.013
3.7	*ζ Cassiopeiae*	0 31	+53 21	+ 2.9	6	1902.10	+0.0024	−0.007	0.023
3.6	*ε Cassiopeiae*	1 47	+63 11	− 5.9	8	1902.08	+0.0058	−0.017	0.043
3.1	*ζ Persei*	3 48	+31 35	+22.1	7	1901.95	+0.0009	−0.017	0.020
0.3	*β Orionis*	5 10	− 8 19	+20.7	24	1901.95	+0.0001	−0.001	0.002
1.9	*γ Orionis*	5 20	+ 6 15	+18.0	10	1901.98	−0.0004	−0.019	0.020
1.8	*ε Orionis*	5 31	− 1 16	+26.7	7	1902.05	0.0000	−0.002	0.002
1.9	*ζ Orionis*	5 36	− 2 00	+18.3	7	1902.52	+0.0005	−0.007	0.010
2.2	*κ Orionis*	5 43	− 9 42	+17.1	10	1901.88	+0.0001	−0.005	0.005
2.0	*β Canis Majoris*	6 18	−17 54	+32.6	5	1901.84	−0.0004	0.000	0.006
1.5	*ε Canis Majoris*	6 55	−28 50	+27.2	4	1902.61	+0.0004	−0.001	0.005
3.6	*η Leonis*	10 02	+17 15	+ 3.5	5	1902.31	−0.0001	−0.012	0.012
2.8	*γ Corvi*	12 11	−16 59	− 7.0	6	1902.27	−0.0113	+0.011	0.162
3.9	*τ Herculis*	16 17	+46 33	−12.7	6	1902.21	−0.0012	+0.031	0.033
3.3	*ζ Draconis*	17 08	+65 50	−14.4	8	1902.19	−0.0021	+0.020	0.024
3.9	*ι Herculis*	17 37	+46 04	−16.4	6	1901.92	−0.0010	−0.006	0.012
4.0	67 *Ophiuchi*	17 56	+ 2 56	− 3.1	4	1902.47	+0.0003	−0.016	0.017
4.5	102 *Herculis*	18 04	+20 48	−10.8	5	1902.62	+0.0003	−0.011	0.012
4.5	*η Lyrae*	19 10	+38 58	− 9.1	6	1902.74	−0.0002	−0.004	0.005
4.1	*ε Delphini*	20 28	+10 58	−26.2	4	1902.55	+0.0006	−0.026	0.027

The distribution of positive and negative velocities in the table shows clearly the direction of the motion of the Sun in space, although the number of stars is, of course, much too small to warrant the determination of the apex or velocity. Conversely, the position of the apex is not accurately enough known to make it seem desirable to tabulate the radial velocities corrected for the solar motion. It is evident on inspection, however, that the absolute velocities of these stars are very small, and a computation, based upon Newcomb's adopted apex (R. A. = 277°.5; Dec. = +35°) and Campbell's solar velocity (19.9 km.), gives 7.0 km. as the mean of the twenty radial velocities after correction for the solar motion; if the sign be regarded, the mean becomes +4.6 km. The exceedingly small proper motions, for stars as bright as these, are striking (in the mean 0″.023; or, omitting *γ Corvi*, which is exceptional, 0″.015), being much smaller than for solar stars of corresponding brightness, and indicate that the stars of the *Orion* type are as a class very remote. The bright stars of the constellation *Orion* evidently group themselves both as to the direction and magnitude of their motions.

The radial velocities of but four of the stars in the list have been previously published, by Vogel and Scheiner in Vol. VII of the Potsdam Publications. They are as follows:

β Orionis	+16.3 km.	*ε Orionis*	+26.7
γ Orionis	+ 8.9	*ζ Orionis*	+14.8

Except in the case of *γ Orionis* the agreement with the values which we have found above is quite satisfactory in view of the character of the spectra, which are most difficult of measurement.

In the course of our observations the following seven stars with spectra of the *Orion* type have been found to have variable radial velocities, and are reserved for discussion elsewhere:[15]

δ Ceti; ν Eridani; η Orionis; β Cephei; ο Persei; π⁵Orionis; ζ Tauri.

[15] See *Astrophysical Journal*, Vol. XV (1902), pp. 214, 340; *ibid.*, Vol. XVII (1903), pp. 150-52.

REMARKS ON THE CLASSIFICATION OF THE SPECTRA

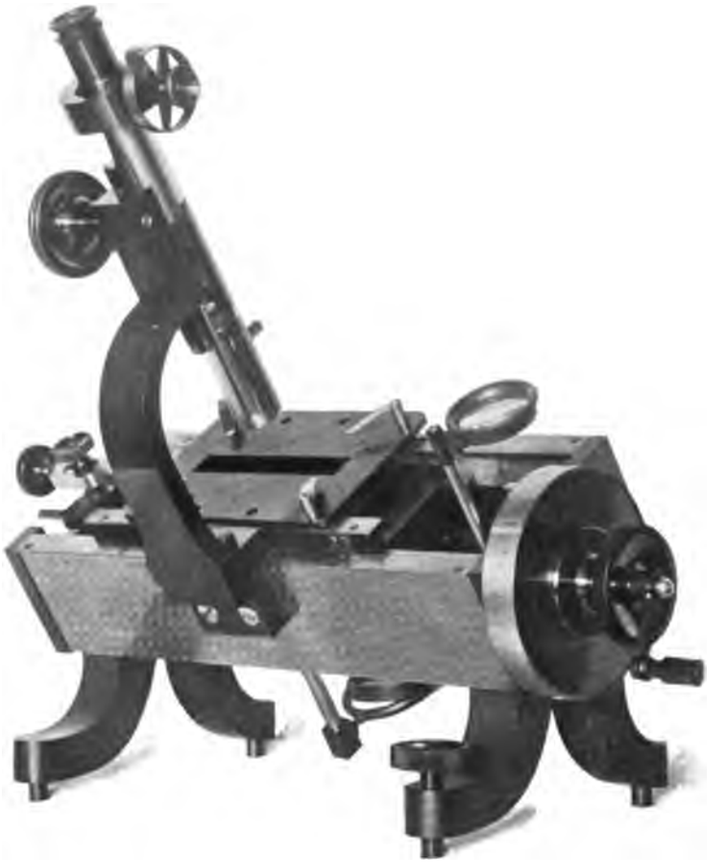
Although all of the stars which we have investigated in this paper belong to type I*b* of Vogel's classification, their spectra vary greatly both as regards the number and the character of the lines present, and a few subdivisions are certainly desirable. Miss Maury's classification is excellent in this respect, and has the great advantage of being based upon photographs which show a very wide range of spectrum, including the valuable H and K region. From this point of view any attempt at classification based upon the limited range of spectrum given by a high-dispersion spectrograph must be distinctly inferior. A further disadvantage in discussing the characteristics of the spectra which we have obtained lies in the fact that the quality of plates best adapted to determinations of radial velocity is generally quite different from that which would be most suitable for qualitative examination; and the greater density demanded may effectually conceal some of the fainter lines present in the spectra. On the other hand, the higher dispersion and consequent broadening of the spectral lines undoubtedly enable one to judge much better of the behavior and character of the individual lines than would be possible with low dispersion and a small scale. At most, however, the classification of such a limited number of stars as we deal with here must of necessity be mainly empirical, and any order of arrangement will represent rather the succession of the various spectra as regards complexity and character of the lines than the sequence of development of the stars themselves.

The lines which occur in the spectra of the stars which we have investigated, and upon which any classification must be based, are due to the following elements: hydrogen, helium, magnesium, silicon, oxygen, and nitrogen. In some stars faint metallic lines also appear, and there are a few lines as yet unidentified. The extent of spectrum included in this examination of our plates is from λ4300 to λ4720.

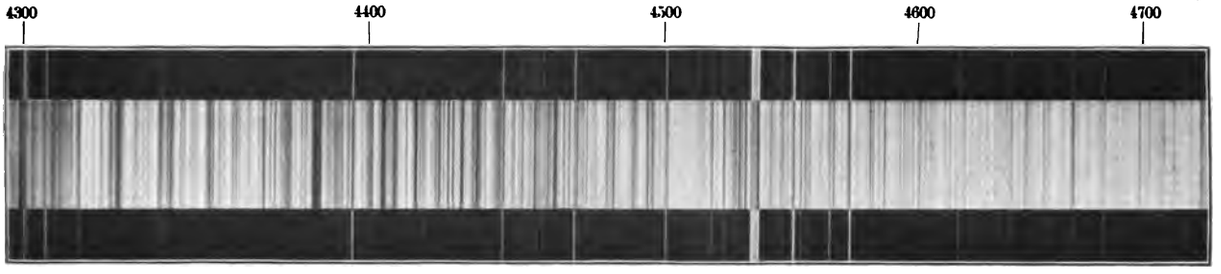
In what are probably the earliest stars of this type in order of development no lines are present with the exception of the hydrogen and stronger helium lines, and these are faint, and extremely broad and diffuse. Most of them contain the line Hγ' at λ4542, which belongs to the series of hydrogen lines first found by Pickering in the spectrum of ζ *Puppis*, and some of them show the line at λ4686, which Rydberg calls the first line of the hydrogen spectrum. Both of these lines are represented by bright bands in the spectra of stars of the Wolf-Rayet type. In the stars which appear most naturally to come next in order these lines disappear, and the hydrogen and helium lines increase in strength, at the same time becoming narrower and more sharply defined. The earliest of this group of stars show traces of the magnesium line at λ4481, and the silicon lines at λ4553, λ4568 and λ4575. While the magnesium line, however, rapidly increases in strength, becoming in the later stars of the group one of the most prominent lines in the spectrum, the silicon lines remain comparatively unimportant. The spectra of the furthest developed stars of this sort, such as ι *Herculis* and β *Orionis*, are characterized by strong and fairly well defined lines of hydrogen and helium, a strong and narrow line at λ4481, and traces of the silicon lines. Faint metallic lines also appear at this point, the most prominent being at λ4550 and λ4584, and indicate the connection of these stars with those distinguished by metallic lines. These last are represented among the stars investigated by ζ *Tauri*, γ *Corvi*, and η *Leonis*, and show a great decline in intensity for the helium lines accompanying the rise of the metallic lines. The magnesium line λ4481, however, is very weak in the case of ζ *Tauri*, though strong in the other two stars, and this fact, together with the remarkable character of its hydrogen lines, which are of a sharpness and brilliancy not approached in any of the other stars, makes the spectrum of this star one of the most interesting that we have encountered.

Up to this point the order of succession of the spectra seems to be fairly clear, but those containing oxygen and nitrogen lines are much harder to classify. This difficulty arises from the fact that in other respects they seem to be almost identical with those which we have just considered. There is the same rise in intensity and increase in sharpness on the part of the hydrogen and helium lines, and the magnesium line appears and develops in almost exactly the same way, reaching nearly,

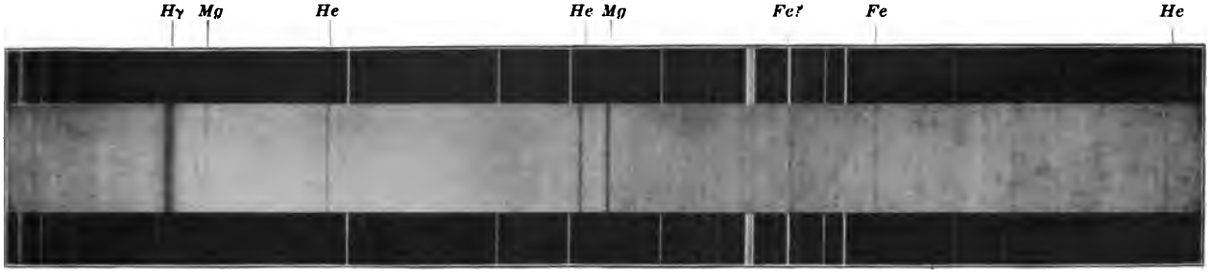
THE BRUCE SPECTROGRAPH WITH ITS ACCESSORIES



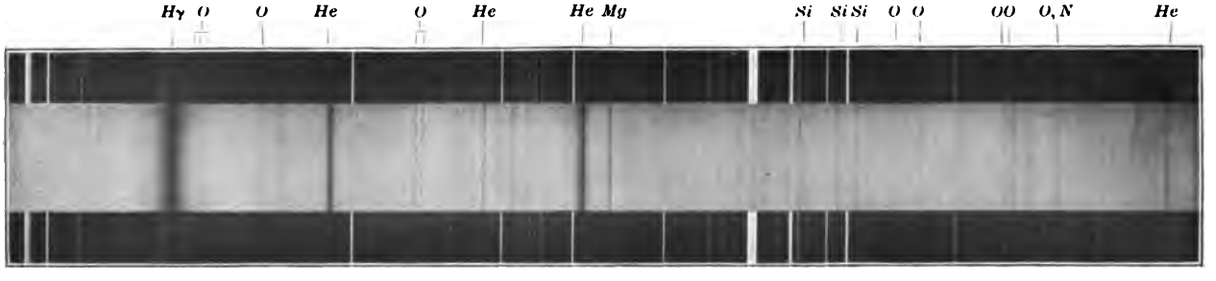
MEASURING MACHINE FOR STELLAR SPECTRA



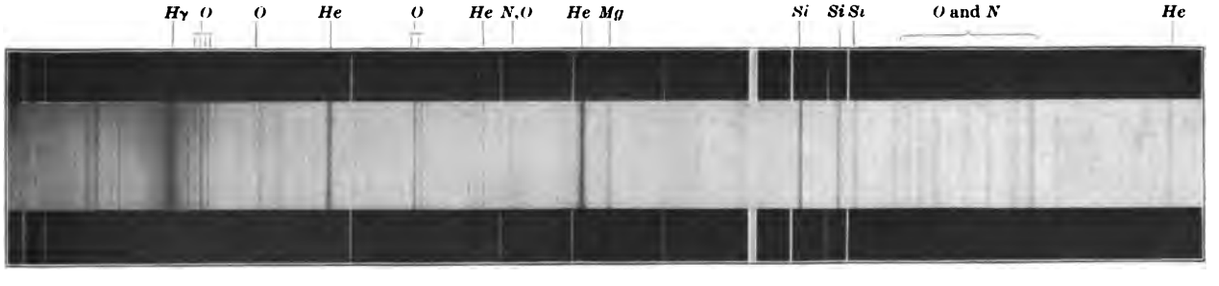
α *BOÖTIS*



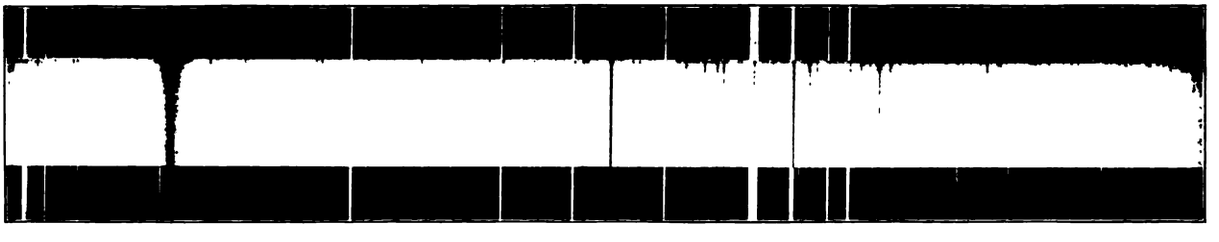
β *ORIONIS*



β *CANIS MAJORIS*



ε *CANIS MAJORIS*



η *LEONIS*

EXAMPLES OF STELLAR SPECTRA
With Comparison Spectrum of Titanium

though never quite, the intensity which it has in such stars as β *Orionis*. On the other hand, we find in the earliest stars of this group the beginnings of a whole series of oxygen and nitrogen lines which develop simultaneously with the hydrogen, helium, and magnesium lines, and attain in the later stars of the group, such as β *Canis Majoris* and γ *Pegasi*, a high degree of prominence. The fact that the three silicon lines, which in the stars considered before never became at all marked features of the spectrum, now follow the behavior of the oxygen and nitrogen lines and gain in intensity with them, is of interest as showing that the stellar conditions seem to be favorable to the simultaneous development of the spectra of the three elements. An examination of these characteristics of the spectrum appears to make the relationship of this group of stars to that which we have considered before one of parallelism rather than succession. For while the order of succession of the individual stars within the two groups is so well defined as to preclude the insertion of either within the other, an attempt to make one follow or precede the other would be equally difficult, without the assumption of the absence of more connecting links than would be justified. Accordingly, it has seemed best to assume a point of division immediately after the earliest stars of the list, and to arrange the stars exhibiting no oxygen or nitrogen lines in their spectra along one branch, while the stars which are characterized by such lines proceed along the other.

In the following table the twenty stars discussed in this paper, together with some others of this type of which we have one or more plates, are collected and arranged. Those whose spectra are very closely allied are connected with brackets, and within the brackets the individual stars are placed in the order of increasing intensities of the lines mentioned.

κ *Draconis* ι *Orionis* S *Monocerotis* λ *Orionis*		Only hydrogen and stronger helium lines present with Hγ′ and λ4686. All lines extremely broad and diffuse. Possibly a trace of λ4481 in λ *Orionis*.
π^5 *Orionis* ϵ *Delphini* ϵ *Cassiopeiae* η *Lyrae* ζ *Draconis* τ *Herculis* ι *Herculis* β *Orionis*	All lines growing narrower and sharper, with λ4481 and helium lines stronger. Traces of silicon lines. No oxygen or nitrogen lines.	
ζ *Tauri* γ *Corvi* η *Leonis*	Helium lines much weaker. Metallic lines grow stronger.	
		ζ *Orionis* ϵ *Orionis* κ *Orionis* — Lines stronger than above but very diffuse. Traces of λ4481 and silicon lines. Traces of a few oxygen and nitrogen lines with strong λ4649.
		67 *Ophiuchi* 102 *Herculis* π^4 *Orionis* χ^2 *Orionis* γ *Orionis* ζ *Persei* η *Orionis* β *Cephei* ζ *Cassiopeiae* ϵ *Canis Majoris* β *Canis Majoris* δ *Ceti* γ *Pegasi* — All lines growing narrower and sharper, with λ4481, helium, and silicon lines stronger. Oxygen and nitrogen lines increase in number and grow sharper and stronger.

DESCRIPTION OF THE PLATES

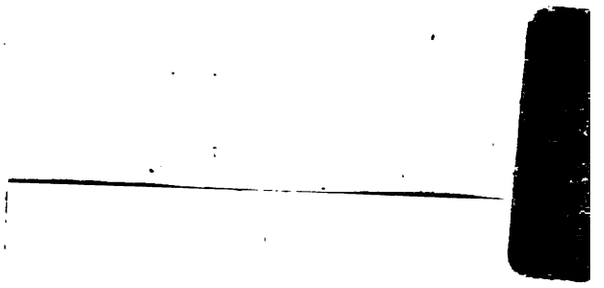
Plate I shows the spectrograph attached to the forty-inch telescope. The cells containing each of the three prisms may be readily seen, rigidly attached to the main casting, in their invariable position. The twenty-four-inch camera tube for camera lens B is seen in place. The chair is set in the proper position for an observer to conveniently look (down) into the guiding telescope. The tube extending from the guiding telescope below to the "goose-neck" above conveys the rays which have been reflected from the polished slit-jaws, and then caught and deflected downward by diagonal prisms within the "goose-neck." To the left of this may be seen the apparatus for producing the comparison spectrum, and the slit, although the scale of the illustration does not permit the details to be clearly apparent. The long rod which would be at the left hand of an observer sitting in the chair is used to assist in guiding, and the whole telescope may be slightly sprung to follow the star. The switches controlling the electric slow-motions in right ascension and declination, which are always within easy reach of the observer, could not be shown when the temperature case was removed, as here. The light inner aluminium case, or prism-box, is seen on the floor at the left below the prisms. The double-walled outer temperature case, which incloses the whole spectrograph, except the slit, is at the extreme right. Behind it is the carriage upon which the spectrograph rests when not attached to the telescope. The induction coil is seen at the left. The box beneath it contains the condenser (at left), the self-induction coil (at right), and the drum upon which is wound the cable conveying the secondary current to the spectrograph.

Plate II shows the comparator made by Gaertner & Co., which is sufficiently described on p. 6.

Several examples of spectra described in this paper are given in Plate III. The negatives used were α *Boötis*, B 300; β *Orionis*, B 282; β *Canis Majoris*, B 215; ϵ *Canis Majoris*, B 461; and η *Leonis*, B 329.

A recent important modification of the pendulum apparatus for vertical enlargement of spectra has permitted the comparison spectrum to receive the same treatment as the stellar spectrum. The positives from which the half-tone blocks were made were prepared by Mr. Ellerman. As shown here the enlargement over the original negatives is vertically almost forty-fold, and horizontally only four-fold (3.8). Any process of vertical enlargement necessarily introduces false lines in the stellar spectra, which may be confusing in spectra having few lines, although inconspicuous in the spectra of the solar type. We have accordingly indicated the chemical origin of all of the more important lines on the three spectra having the fewest lines.

The plates have not been retouched by photographer or engraver, but the intensity of the continuous spectrum was rendered as uniform as possible by shading the brightest parts during the process of enlargement.



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Radial velocities of twenty stars h
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